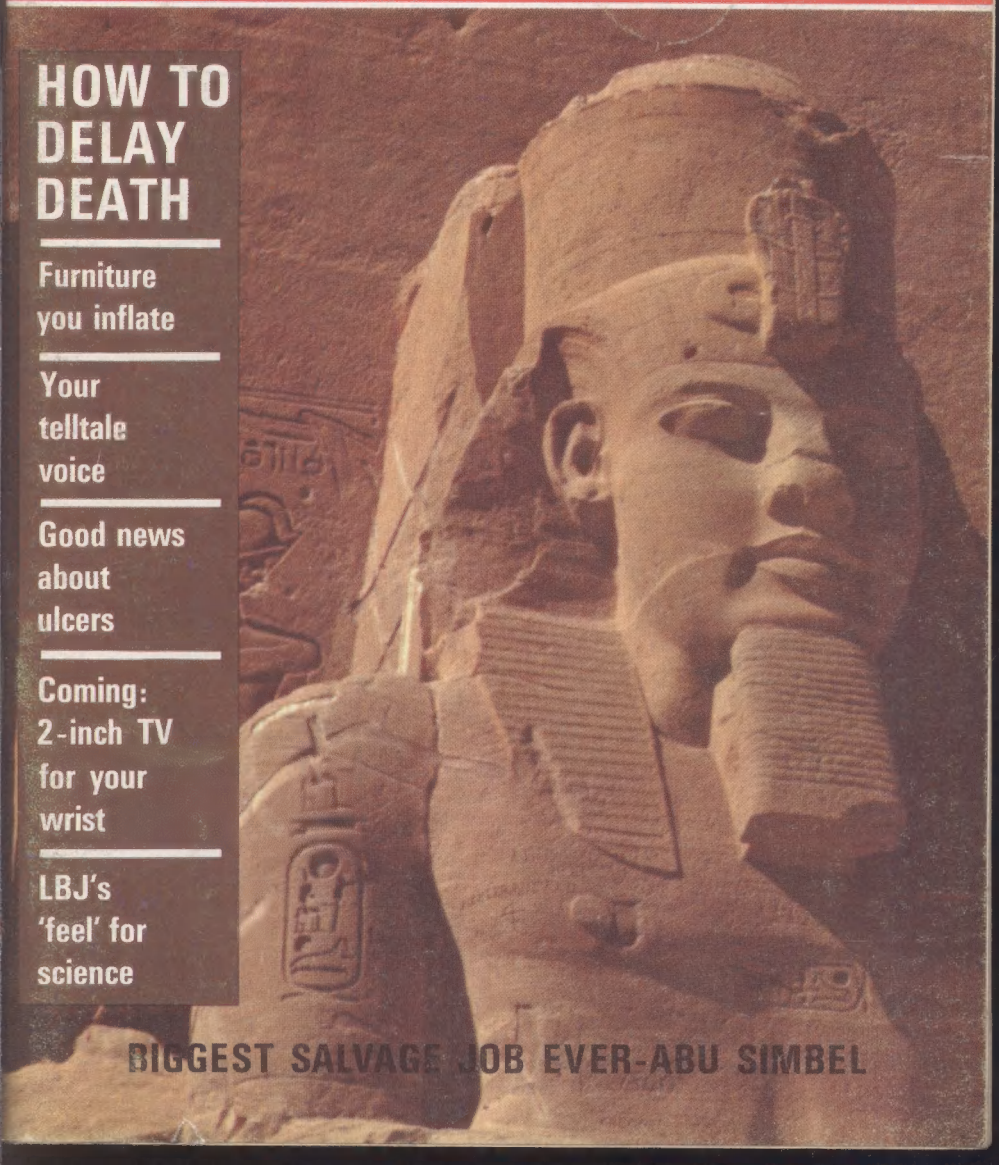
The science news monthly

SCIENCE DIGEST

APRIL 1965 35 CENTS ICD



HOW TO DELAY DEATH

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LBJ's 'feel' for science

BIGGEST SALVAGE JOB EVER-ABU SIMBEL

Dinosaur footprints on the ceiling

A DINOSAUR, plodding through the swamps of what is today Queensland, Australia, unwittingly left his footprints for posterity. The imprints he left were covered by mud which filled the depression. The swamp trees changed to peat and later to coal while the mud changed to shale.

Recently, some 200 million years after the dinosaur took his stroll, two miners found the prints in a coal seam 700 feet underground in the Rhonda colliery, 20 miles west of Brisbane, the capital of Queensland. The miners exposed the prints by cutting beneath them.

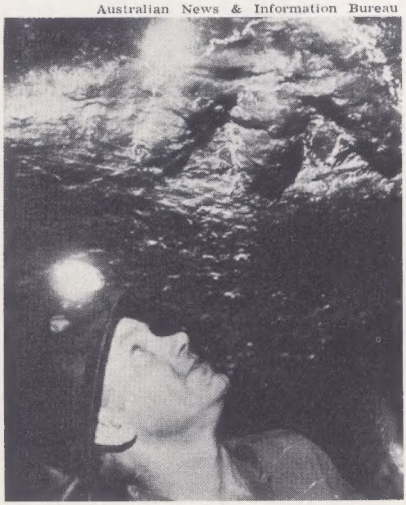
Scientists who examined the prints say they were made in the middle Triassic geological period when the district's coal reserves were believed to have been laid down.

The prints—one less distinct than the other—are 3 feet apart but clearly show the outline of the creature's three toes. The left foot impression is 17 inches from middle toe to heel and the width between the extended toes is 15 inches. The prints have the characteristic pigeon-toes of the dinosaur.

The prints may be the oldest ever found anywhere. Dinosaur prints have also been found in the U.S., Europe and Africa, but these were believed to have been made in the upper Triassic period, several million years later.

It is estimated the creature was about 20 feet tall, walked on its hind legs and was a flesh eater.

Australian News & Information Bureau



Left: Geologist Alan Bartholomai examines dinosaur footprint found in coal mine. Below: Plaster cast impression of the dinosaur footprint. The cast is as good a scientific record as the actual print.

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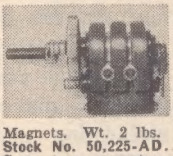

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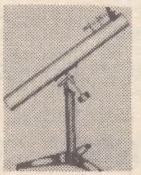

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DOCTORS today are learning how to treat patients who technically don't exist.

Of course, the key word there is "technically." Technically, in normal usage, a person's life begins when he's born and ends when his heart stops beating and/or he stops breathing. But two articles in this issue describe how medical scientists now are studying ways to give a patient life before he's born and after he's clinically dead.

Treating a Baby Before Birth tells of the work now being done by doctors to diagnose possible ailments in an unborn child and actually treat the child if necessary.

How to Delay Death tells of the work of medical researchers that has led to the restoration of life to test animals after they had "died."

THIS MONTH

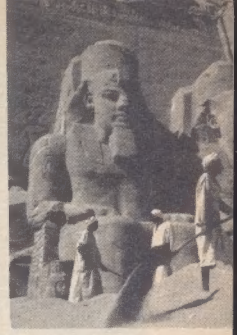
Nothing is what it seems any more, not life, not air (see *Stop Breathing and Live*), not animal life (see *The Fish That Walks, Breathes and Changes Sex*), not food (see *Proteins from Petroleum*), not airplanes (see *Helicopter That Isn't*), not even the chair you sit in (see *Furniture You Inflate*).

Change is unsettling and can be destructive if it isn't for the better. But the casting off of physical and mental shackles, we think, makes science the most exhilarating area of knowledge today. We hope you catch this excitement in every issue.

THE EDITORS

SCIENCE DIGEST

Twenty-ninth year of publication



After 3,000 years, the giant Egyptian temple of Abu Simbel must be moved. A complete explanation of what is involved in this astoundingly difficult salvage job begins on page 48.

APRIL • 1965 VOL. 57, NO. 4

SCIENCE THIS MONTH

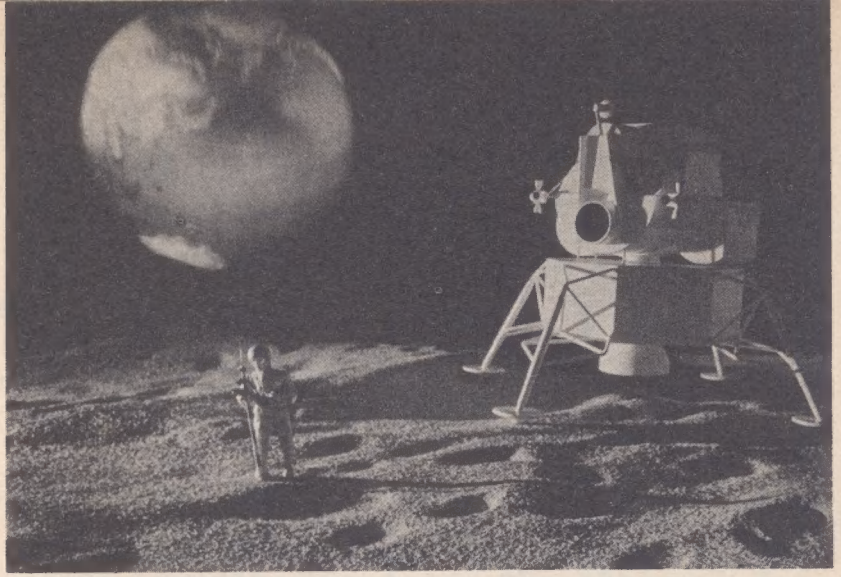
SCIENCE PANORAMA

SCIENCE MISCELLANY

THE LATE SCIENCE NEWS

OF MICE AND MEN. British scientists have experimentally fused cells of mice and men. The hybrid cells lived for as long as 15 days in tissue culture. They appeared to carry on most normal cell functions. Scientists were astounded that cells from such disparate species could have been mated in the first place, much less survive. The success of this experiment opens new approaches to the study of the effects of cytoplasm on gene action, and other problems that many consider the most important in biology today.

CONTROVERSIAL TREATMENT. A doctor who devised a treatment for a disease that kills 25,000 infants in the U.S. every year is out of a job as a result of his discovery. The disease is called hyaline membrane disease. It attracted wide attention because it was responsible for the death of Patrick Bouvier Kennedy, infant son of President Kennedy, in 1963. Dr. Daniel Stowens reported last year that a simple Epsom salt enema had saved the lives of 28 infants with the disease. The treatment as described in newspaper stories angered Dr. Stowens' associates at Louisville's Medical School and Children's Hospital."They made it tough for me," said Dr. Stowens, "so I quit." Louisville Medical School is not now using the treatment, but Dr. Stowens says it is being tested by about 500 doctors.



SCALE MODEL MOON. The final photo transmitted by Ranger VII before it crash landed on the moon has been used to construct a scale model of the lunar surface (above). Astro-geologist Dr. E.M. Shoemaker employed a photometric scaling process to make the model. The astronaut and LEM are on the same scale as the craters in the surface. Photos taken by Ranger VIII are now being analyzed and will also be used to help man know what to expect when he lands on the moon.

SATELLITE WITH WINGS. Tumbling over and over in orbit, the giant Pegasus satellite is catching meteoroids on its aluminum wings, and sending information about them back to earth. The wings, which have a span of 96 ft. and a surface area of 2,300 sq. ft., are constructed with skins of different thicknesses and are able to distinguish between meteoroids that might be dangerous to space travel and those that are too small to do any harm. The highly accurate launching of Pegasus was another success for Saturn I, forerunner of the Saturn V moon rocket.

SNAP 8 GETS SUPPORT. A congressional committee urged NASA to find a way to continue work on SNAP 8, a project to use nuclear power in satellites. The project was dropped from NASA's budget before it was sent to Congress (see "Row Over Rockets," page 44). Attempts will probably be made to restore all deleted projects to the budget.

MONEY, MONEY, MONEY. Big science costs big money. Thirty of the nation's leading theoretical physicists want vastly increased public support for studies in high-energy physics, including, possibly, the construction of a trillion-electron-volt atom smasher. Cost: somewhat less than a billion. A panel of the National Academy of Sciences proposed expanding private and governmental spending on geophysical research from the current $25 million a year to $65 million annually by 1975, in a vigorous 10-year plan.

MOHOLE DRILLING SITE. The main drilling area for Project Mohole, the hole to be drilled through the earth's crust to the mantle, will be in the mid-Pacific about 100 miles north-northeast of Maui in the Hawaiians.

HIGH-SPEED RAIL RESEARCH. President Johnson has asked Congress for $20 million to push research on high-speed rail transportation (see "Speed-New Hope For Railroads," Dec.'64).

REDUCED SONIC BOOM. Engineers now believe that sonic booms from proposed supersonic airliners can be significantly reduced by relatively minor changes in design.

BALDNESS FRENZY. Two University of Pennsylvania School of Medicine researchers who have had some success in testing a hormone cream as a baldness cure (see Science Digest, March '64) are being flooded with requests from all parts of the world asking for the cream. The Journal of the American Medical Assn., however, stated, "Most physicians should refrain from use of the treatment until its safety has been more fully demonstrated." The researchers, Drs. Christopher M. Papa and Albert M. Kligman, are now testing young men who are becoming prematurely bald. The National Institutes of Health are testing the blood of those under treatment to see if the hormone is penetrating the body enough to present a hazard to a person's health.

ALCOHOL DANGER. A good diet will not protect a heavy drinker from liver damage. Recent tests on rats have shown that they develop liver abnormalities if as much as a third of their daily caloric intake is from alcohol, no matter how adequate the rest of their diet is. Before these tests many believed that given an adequate diet alcohol was no more damaging to the liver than sugar. The tests, reported by Dr. Charles Lieber of the Cornell University College of Medicine also indicated that high alcohol intake produces blood changes.

CONCORDE COMPROMISE. The British-French project to build a supersonic airliner, which was almost scuttled, will proceed, but production deadlines will be delayed.

CELESTIAL "INTERLOPERS". Astronomers have located a strange type of stellar object, dubbed an "interloper." There are indications that the sky may be peppered with such objects and an extensive study is underway to find out how many there are. Some scientists believe the new objects may be a form of silent quasar. Ouasars have already thrown theoretical astronomy into a turmoil.

LYSENKO'S DOWNFALL COMPLETE. Soviet biologist Trofim D. Lysenko and his followers have been removed from their last important scientific posts, and more vigorous efforts are being made to erase their influence on genetics (see "Again, Lysenko," Jan. '65).

QUOTE OF THE MONTH: "Close and understanding accord between science and public affairs is an imperative for free societies today. . . .As no other force has contributed more materially to our effective pursuit of happiness in America, so it is true that no other force is now requiring of us the more careful examination and re-examination of the workings,values and aspirations of our society. Science is changing many of the very premises on which our greatly successful American society has been built over the past two centuries. If we are to strive toward our society's continuing success and further greatness, we must not merely commit ourselves to its support--we must involve ourselves in seeking to understand the profound changes which it promises." PRESIDENT LYNDON B. JOHNSON. (See "LBJ's 'Feel' for Science," Page 9).

PERSONALITY OF THE MONTH

LBJ's 'feel' for science

by Flora Rheta Schreiber

"EVEN now, a rocket moves toward Mars. It reminds us that the world will not be the same for our children, or even for ourselves, in a short span of years."

When President Johnson was inaugurated on January 20, those were among his first words.

A little further on in his Inaugural Address, he returned to the rocket:

"Think of our world as it looks from that rocket that's heading toward Mars. It is like a child's globe, hanging in space, the continents stuck to its side like colored maps. We are all fellow passengers on a dot of earth. And each of us, in the span of time, has really only a moment among our companions."

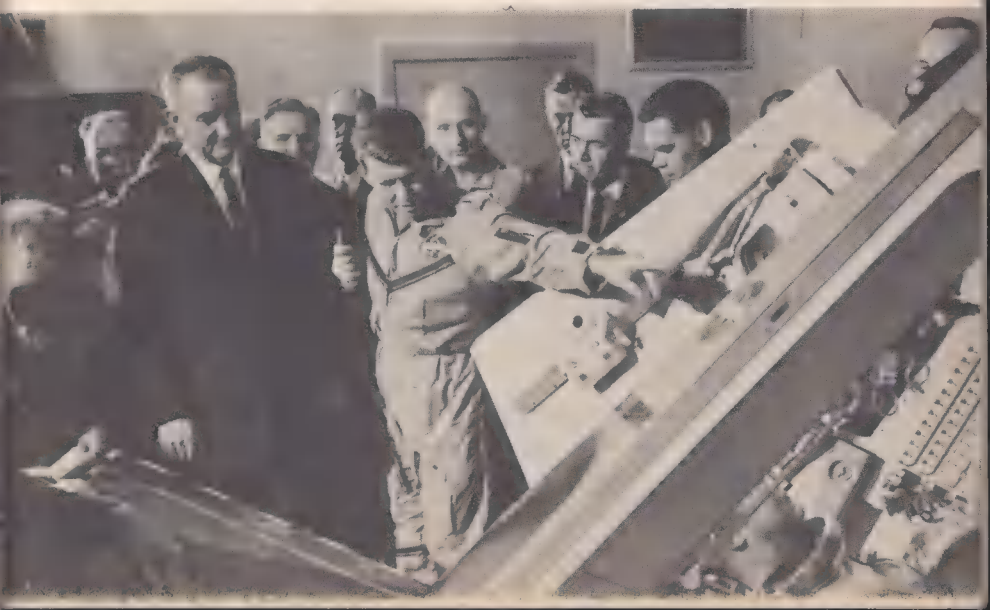
Never before has a President of the United States been so "far out," so science-minded.

That fact promises to do more to change the way we live than perhaps even a dozen of the biggest scientific breakthroughs of recent decades.

Lyndon B. Johnson is no scientist, but he understands the import of science, and as he sits in the world's tallest political saddle, science is probably going to move from theory to action a lot faster in the next few years.

The word "action" is a key one.

President Johnson is briefed on the Gemini spacecraft by astronaut Wally Schirra during the President's visit to the Cape Kennedy space center last autumn.



President Johnson has gone out of this world, millions of miles into space, and looked at the planet we live on as a speck in the cosmos.

Before science can move out of the lab to improve our lives, it must be transformed into products and services. It must make business sense; it must overcome social prejudice and common ignorance. A political leader with the adroitness and following that Mr. Johnson commands can make the difference between possibility and actuality.

And don't forget that our 36th President is a Bachelor of Science in education, and a former teacher, a man bent on exciting others to know what he knows.

What does he know, scientifically speaking?

He knows, first, that we already have, right now, the science and technology required to wipe out a vast part of the misery and disease the world suffers. He knows we have the resources to undertake the research still needed. Consider what he has recently proposed:

1) An all-out drive on ways to have the nation's poor join in the national prosperity.
2) A three-pronged laboratory attack on cancer, heart attack and stroke.
3) A program to bring speed and service to our railroads.
4) A plan to keep pollutants out of our air and water.
5) A broad-scale study into ways of making fresh water from sea water.

Where does Mr. Johnson get this "feeling" for science?

For one thing, he is a more "modern" man than any of his predecessors except perhaps John F. Kennedy. Yet most observers would say that President Kennedy was "modern" in the humanistic rather than in the technical, scientific sense.

Mr. Johnson often speaks of his home country in Texas. His interest in desalinization undoubtedly springs from his personal knowledge of how fresh water can transform an arid, forbidding land into a lush, productive countryside.

There, too, he has become an expert in animal husbandry. His Herefords, for instance, have won a number of blue ribbons.

He is also interested in mechanical gadgets of many varieties. On his orders, intercoms have been installed at the ranch so that everyone—even the cook—is always within range of his voice, and he within everyone else's.

And, as innumerable news events have testified, never has a President more often or more effectively used the telephone and television.

One of President Johnson's scientific interests stems from the time of his nearly fatal heart attack. Coming close to death, he addressed himself to the question: "Who am I?" The question de-

veloped in him a strong interest in genealogy and genetics. The interest in genealogy was not the family's first. His mother once assembled a book called "Kissing Cousins" detailing the family's history. But he decided to find out for himself about genetics and plunged into some heavy research on the subject.

Mr. Johnson's heart attack, in fact, evoked an interest in every detail of his medical history. For a while, he used to carry his cardiograph around.

These areas of the President's scientific interest developed more accidentally than by design. Yet today, few people question that he has a strong grasp on the science and technology of our times.

In his reference to the Mariner shot to Mars, in his Inaugural Address, LBJ was in a familiar environment. As Vice-President, he directed the burgeoning programs in space that we were beginning to undertake. And space is still one of his commitments.

All of this is even more significant than merely exciting. American politics has traditionally demanded some form of nationalistic posture. A few recent Presidents have talked up the occasional need to ignore national boundaries. But this is the first time that a President has gone out of this world, millions of miles into space, and looked at our whole world as a speck in the cosmos.

Hold on to your Stetsons.

Profile of an astronaut

IF THERE is such a thing as an "average astronaut," he's approaching 35 years of age, weighs 161 pounds, is just under 5 feet 10 inches tall, has brown hair, blue eyes and a crew-cut.

But from there on, a composite picture of NASA's 28 astronauts at the Manned Spacecraft Center shows him to be anything but average.

He's a test pilot with more than 3,000 flying hours, 2,500 in jets and some in rocket ships and spacecraft. He's flown about 20 combat missions in Korea and during World War II.

He holds a bachelor of science degree and a master's degree, and has done some work on his doctorate. He graduated in the top five from a major American university, and attended a military test pilot school. He is still in the military service.

Actually, five of the 28 are civilians, though all have served in the military service as pilots. More than a fourth of them have flown in combat, and some have shot down enemy planes. None were aces.

As a group, the astronauts hold 39 academic degrees and have flown more than 83,000 hours.

The youngest is 29; the oldest, 41. The tallest is 6 feet; the shortest, 5 feet, 6½ inches. Twelve are Air Force officers, ten are Naval officers, one is a Marine officer, and five are civilians. All are married and have a total of 74 children, 41 boys and 33 girls.

The fish that walks, breathes, changes sex

BECAUSE a young Indonesian student on a biology field trip noticed several hundred fish crawling from one pond to another, scientists are learning new things about vertebrate evolution and sex differentiation.

These strange fish, known as *Monopterus* albus, don't just crawl, further investigation revealed that they also breathe air and change sex!

When that first encounter with *Monopterus,* the air-breathing, burrowing, brownish, eel-like Asian fish, took place ten years ago, Karel F. Liem (above) was working on a degree in biology at the Univ. of Indonesia in Bandung. A native of Java, Indonesia, with an Indonesian-Chinese father and a Dutch-German mother, Liem went on to secure an M.A. in zoology in Indonesia and a Ph.D. in zoology at the University of Illinois.

Dr. Liem's research interests involve the application of his knowledge of fish to human anatomy. He is most interested in studying the effect of mutational muscle and bone changes on varying parts of the body, sex reversal in fish and other vertebrates and blood vascular systems in air breathing fish.

One of Dr. Liem's primary research interests are the crawling fish of Asia. "The most startling thing about them," he says, "is that they change sex. All of these fish start as females and at a certain stage in their development all become males."

Having verified this in the laboratory, Dr. Liem began to contact other scientists around the world to find out more about what is known of this phenomenon. "One group in England," he says, "is trying to isolate specific hormones in this fish for possible use in producing a male birth control pill.

"Combined knowledge on this

subject could lead to important discoveries," Dr. Liem adds. "When a fish changes sex, there are great hormonal upheavals and since the sexual development of the fish is not vastly different from that of higher animals, this knowledge can tell us much about human sex differentiation."

Research interests

Dr. Liem's other major research interest also involves these strange fish which have fascinated him for a decade. He is conducting extensive research on their blood vessels and blood vascular system. The capacity of oxygen uptake of blood in these fish changes from water to land and their adaptability can reveal much about the ability of animals to adapt to change, explains Dr. Liem.

"In the shift from aquatic to land life many modifications are necessary in the respiratory, and blood vascular systems and locomotion," says Dr. Liem. "In *Monopterus* the respiratory function is performed by the lining of the mouth and gill cavities, the gills being vestigial. Gills in air would stick together, which means a reduction in respiratory surface, and the fish dies.

"In aquatic fish, the blood pumped by the heart to the body has to be oxygenated in the gills. As a consequence, the blood pressure drops significantly before reaching the different body tissues.

"In *Monopterus*, one of the aortic arches bypasses the respiratory capillary bed and forms the aorta which distributes the blood to different organs, simulating the conditions of terrestrial vertebrates.

"This aortic arch enables the heart to pump the blood to the different parts of the body under much higher pressure than in the aquatic fish. Since the heart does not have the separation devices found in higher vertebrates, the blood is mixed: oxygenated and deoxygenated. But this mixed blood is distributed at a higher pressure and at a faster rate. This seems essential for land-living vertebrates.

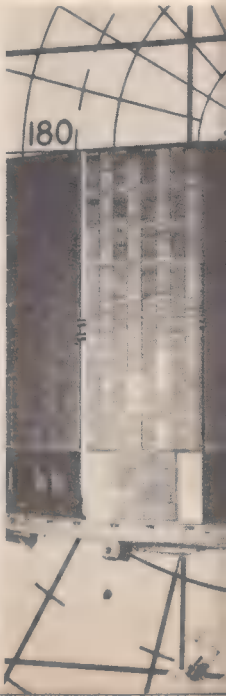
"While this fish and others like it are not the biological missing links which scientists constantly seek, they do show a parallel development which is very likely like that of the historical evolutionary shift from water to land creatures," says Dr. Liem. "There seems no end to the information we can learn about man from these adaptable creatures."

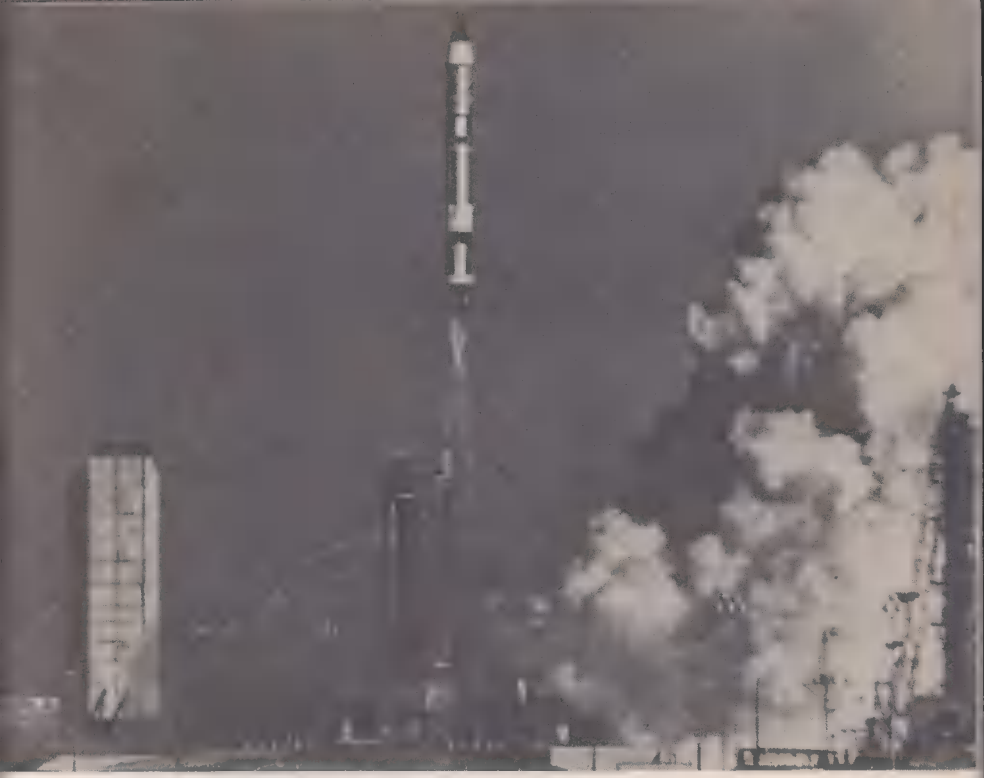
THE SPACE PICTURE

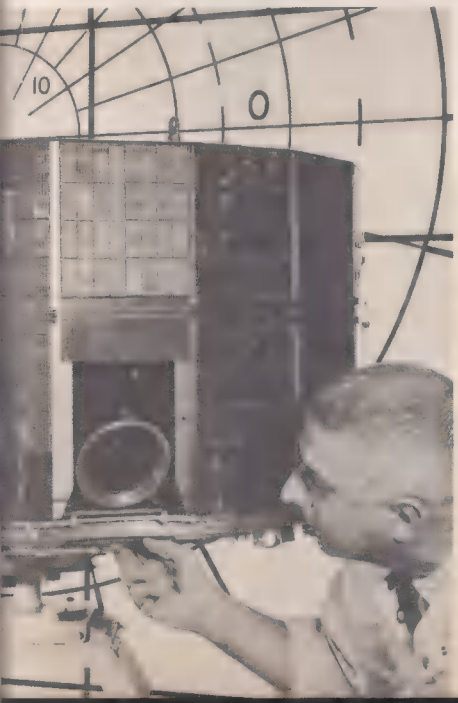
Gemini – 10 ... 9 ... 8 ... 7

Above: Astronauts Young and Grissom, pilots for this month's scheduled Gemini shot, and Chris Kraft, Director of Flight Operations for the Manned Spacecraft Center, meet the press after the successful flight of NASA's Gemini Titan II spacecraft. Right: Titan II launch vehicle boosts Gemini spacecraft II from Cape Kennedy on a 2127.1-mile suborbital flight to test maximum reentry heating conditions along with other spacecraft systems. The 19:03-minute flight reached a speed of 16,708.9 mph and an altitude of 98.9 miles.

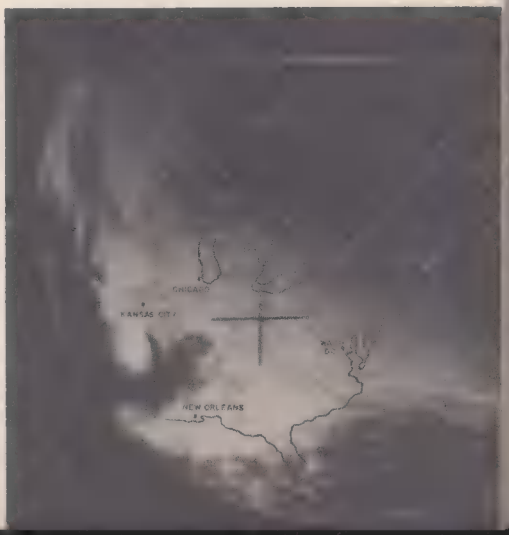
Below: Gemini spacecraft is successfully recovered about 2,100 miles downrange by the recovery forces of the U.S.S. Lake Champlain. The landing was only 16 miles short of the programmed landing area.







Left: Technician runs final camera tests on NASA's new "cartwheel" Tiros IX weather satellite prior to launching. Below: Picture of a rainy weekend for most of the U.S. is sent by Tiros from 1,419 miles over the Mississippi and Ohio Valleys.



THE PROGRESS OF MEDICINE

Ulcer treatment: Blow up

BLOWING your stack may be better than any drug in control of peptic ulcer.

A University of Chicago specialist expressed the belief in more professional language when he wrote:

"Ulcer patients have been characterized as tense hard-working ambitious and sensitive individuals with a tendency to repress their turmoil. Removal of a source of irritation, encouraging the patient to express the anger, frustration, or resentment he may feel, and the release of tension in pleasant recreational activities may be more helpful than drugs in the control of peptic ulcer."

Formal psychotherapy is not necessary, adds Dr. Joseph B. Kirsner, professor of medicine, in discussing "facts and fallacies" of current medical therapy.

While the exact cause and cure of peptic ulcer is unknown, present treatment nevertheless is effective for most patients, providing they cooperate and their physician has enough experience and knowledge, says Dr. Kirsner.

He also notes:

• Adjusting personal problems at home or at work may alone bring about healing of a difficult ulcer.

• While men have more frequent and severe ulcers than women, there is no evidence that giving female sex hormones is protective.

• There is no evidence that coarse or seasoned foods are responsible for developing peptic ulcer or that soft diet enhances healing. However, some foods are irritating to individual patients and it is practical to eliminate them.

• The occasional use of anti-acids —"one teaspoon or one tablet after meals"—is worthless. Dosage must be adjusted to individual needs.

• The ideal anti-acids that effectively neutralize gastric acidity for long periods without unfavorable effects have not been developed.

• Moderate to mild smoking probably does not increase gastric secretion, but in patients with a chronic recurrent ulcer excessive smoking may be harmful.

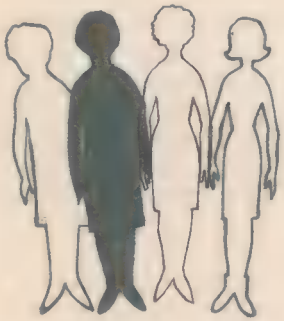
• Alcohol irritates the stomach lining and tends to increase acid secretion. Large amounts of coffee should be avoided.

• Mild X-ray irradiation of the stomach eliminates acid secretion for 6 to 12 months in less than 10 percent of patients.

• The notion that recurrences of peptic ulcer are inevitable, regardless of any treatment, is incorrect.

Why women are aging more slowly

Women are growing older—later. Nature, without assistance from cosmetics, has contrived to bless womanhood with a longer period of "endocrinologic youth" the Journal of the American Medical Assn. states. An editorial cites a British study that the median age of menopause has risen to about 50.1 years. This represents an increase of about four years in the age of menopause compared with a century ago.



The biological gain apparently is not limited to Great Britain. A comparable delay appears to be occurring in most European countries. No statistics are available for the United States but it is assumed they would show the same gain.

"There is no certain explanation for these changes, although better nutrition and improved environmental conditions may play important roles," the AMA says.

It could not be due to smaller families than a century ago, since it is known that the fewer the pregnancies the greater the likelihood of an earlier menopause.

The trend has been upward for some centuries, according to British authors. Their analysis of early literature suggests that in ancient times, the mean age of menopause was about 40 years and between 1500 and 1800, about 45 years.

Coupled with the longer youth in the middle years is the observation that adolescence is being reached earlier. In Britain, the average age of menarche has fallen from 15.5 years in 1850 to 13.1 years in 1950.

The pituitary gland may be involved in both changes, it has been suggested. Whatever the reason, the combination of an earlier age of menarche and a later age of menopause provides material for "cheerful speculation," in the AMA's view.

"It is possible these changes connote a decreased rate of 'physiological degeneration,' that is, a decreased rate of aging in women in recent decades," the AMA says.

Don't take chances with cancer

The odds are 3 to 1 in favor of a lump on the breast not being a cancer, but a noted British surgeon advises women not to guess. Every lump demands a check by a doctor to rule out cancer, says Sir A. Lawrence Abel of London.

Even in the one-out-of-four chance the lump is cancerous, the patient's life can be saved if surgery is performed early enough.

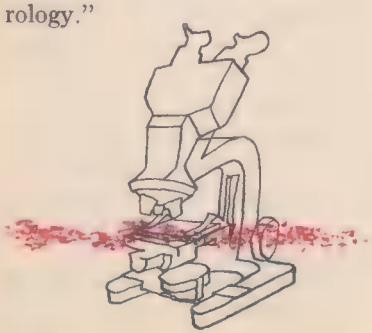
Bacteria secrete cyanide

Bacteria that manufacture and secrete cyanide, one of the most lethal of poisons, have been found to be responsible for the sudden blood poisoning and rapid death that occur in some burn victims. The rod-shaped germ, a species of pseudomonas, thrives in dead skin. It produces the cyanide at the same time as a greenish blue pigment excreted by the patient's kidneys. When physicians see the "green urine," they know the patient's fate is sealed.

On the trail of viruses?

"Do viruses cause cancer?" The director of the National Cancer Institute asked the question and gave his own answer: "For animals, the answer is 'Yes'. For humans, it is still unknown."

But the evidence for humans is piling up and the NCI is launching a $10 million virus-cancer-leukemia research program directed toward "preventing human leukemia by production of an effective vaccine or some other control method of virology."



Speculating on the outcome, the NCI director, Dr. Kenneth M. Endicott, believes that viruses responsible for human cancer may well be widespread in the population, but almost in no form of cancer will a virus be the only factor. It may be that something other than the virus will prove the weak link in the chain of events leading up to the cancer.

Gold artery patches

Commercial gold leaf, when electrostatically charged, has a remarkable blood-stopping effect on wounded arteries and veins. The electrostatic charge is conferred on gold leaf merely by stroking a camel's hair brush against a rubber comb and then touching the leaf with the charged brush. The gold leaf is then placed directly on the site of the hemorrhage and acts like a patch.

Dr. John P. Gallagher of Providence Hospital, Washington, D.C., first used the procedure in human beings on a nine-year-old boy who had sustained a compound depressed fracture of the frontal bone. The scalp had been badly torn and the bone was splintered. The lining of the brain was exposed and torn. The wound was cleaned and the lining sutured. Charged gold leaf was laid over the suture line to seal it. Other pieces of gold leaf were placed over smaller tears to prevent further leakage of cerebrospinal fluid.

In other patients, gold leaf was placed on arteries, veins and capil-

laries from various regions that have posed a serious problem for generations of surgeons. These were areas that could not be sutured. Hemorrhage usually is arrested with gauze packs or drugs. The purpose is to form a clot. But if the circulation through the blood vessel is sluggish or if other conditions exist, the clot may plug the entire blood channel and close off the vessel just as completely as if it had been sewed.

Charged gold adheres to the outside of the wall of the vessel and does not rely on clot formation. The strength of adherence between the gold leaf and the vessel wall depends on the amount of electrostatic charge conferred on the leaf.

There are numerous substances which take on an electrostatic charge when rubbed against a dissimilar substance and very large charges may be built up merely by continuing to rub two dissimilar substances together. When a camel's hair brush is stroked against a rubber comb, the brush becomes charged positive and the comb, negative. When the positively charged brush is touched to the gold leaf, and this in turn is touched to the living tissue, the charged leaf is promptly released from the tip of the brush. Thus, living tissue must have a negative charge; otherwise the gold leaf would be rejected immediately.

Gold is ideal for use in human tissues because it is chemically inert. There is little if any adverse tissue reaction.

Fingerprinting the newborn

Fingerprint analysis has long been an integral part of scientific criminal investigation. It now may become a valuable method for early detection of neurological difficulties in newborn infants.

The U.S. Public Health Service is conducting an investigation in the patterns of palm and fingerprints of patients with such disorders as hydrocephalus (water on the brain) and Mongolism. The study will involve about 5,000 patients. A retired Washington, D.C. police officer and fingerprint expert is reading the prints.

Totally new antibiotic

The first totally new antibiotic introduced in several years is Lincocin. It has a chemical structure unlike that of any other drug now available. Its unique structure makes it effective against many bacteria which resist other antibiotics. It has been used to control a spectrum of infections ranging from pneumonia to acne.

Dr. Harold J. Upjohn, medical director of the Upjohn Co., says it has had a 90 percent or better success rate against such infections as tonsillitis, pharyngitis, scarlet fever, abscesses, wound infections, pneumonia, sinusitis, infections of the middle ear, acne and bronchitis.

Patients in space suits

Tomorrow's hospital may see the patient garbed in an astronaut-like suit and an oversized helmet bristling with wires and tubes to better control such atmospheric elements as temperature, moisture and air movement.

In proposing this in the journal Hospitals, architect E. Todd Wheeler says the space-suited patient may be wheeled into an operating room in which the oxygen content has been reduced with carbon dioxide to eliminate the hazard of fire or explosion. He may look up into the eyes of a surgeon wearing an air and pressure-conditioned helmet. Only the area of surgery would be exposed.

To a population growing more and more accustomed to unusual garb in the space age, the prospect of a therapeutic atmosphere suit may not be so frightening, Wheeler says.

However, there will always be patients who prefer a more humanized form of hospitalization with its "human touch" to the technically advanced systems and their mechanized forms.

When a doctor isn't needed

The Warren Commission's recommendation that a physician always be near the President of the United States on his travels in case of an emergency "bespeaks an almost childish insistence on the magic of the healing doctors," says the American Medical Assn.

There are instances, of course, when the immediate availability of a physician can be life-saving, but in one person's life such an instance is so unlikely that it in fact does not even occur in most lives.

The AMA asks other questions: Is it not possible that, knowing medical assistance is "immediately available," a sense of false security will be engendered in those charged with guarding the President from an assassination attempt? Is it possible to find in one physician all the experience necessary to handle all of the various hazards to which the President's life is exposed?

The AMA suggests that physicians in several specialties be "on call" during the President's visit to a particular city.

Automatic blood sorter

Auto-analyzer is capable of determining automatically A, B, AB and O blood groups and Rh positive and negative blood types. It was developed for the Amer. Red Cross.

THE New York Red Cross has become the first Blood Donor Center in the U.S. to install an automated system for routine grouping and typing of blood.

The automatic blood processing machine, known as an auto-analyzer, is capable of determining automatically A, B, AB and O blood groups and Rh positive and negative blood types. The eight-channel system employs an electronic colorimeter to "read" tested blood samples and automatically records results on a graph.

Jointly developed by Technicon Instrument Corporation, Chauncy, New York, and the Red Cross, the machine operates as follows: Test tube samples of donors' blood are first centrifuged to separate the red cells and the plasma. These test tubes are then placed on a turntable in the machine where a sampling device distributes the plasma into four channels and the red cells into four channels.

One of each of the four channels is a control sample and two of each test for A, B, AB and O groups. The fourth channel of red cells tests for Rh positive or negative, while the fourth channel of plasma is used for testing for Rh antibodies.

The direct testing of the red cells is accomplished by the addition of anti-A sera to one sample and anti-B sera to another. If the sample cells are group A, the anti-A sera will cause them to clump; if group B, the anti-B sera will cause them to clump; if group AB, both sam-

The automatic blood sorter will enable three and a half times as much blood to be tested by half as many technicians as in the past.

ples will clump, and if group O, neither sample will clump.

Following the introduction of the anti-A and anti-B sera, there are two T-joints in series. By gravity and pumping, the clumped cells go down one of the T-joints while the unclumped cells continue. The cells left in the channel are broken down by the introduction of a hemolyzing agent such as distilled water, releasing the red coloring. At the final step, a colorimeter measures the amount of red coloring due to free hemoglobin in the sample by means of a light beam and records the results on a graph. A measure of a large amount of coloring, shown as a peak on the graph, indicates that cells are not clumped while a low measure of coloring indicates clumping.

Blood grouping

If the sample to which the anti-A sera was introduced records little or no color, the blood is group A. If the sample to which the anti-B sera was introduced records little color, the blood is group B, and if both samples record a large amount of color, the blood is group O, and if little color is indicated in both channels, the blood belongs to group AB.

The reverse system is used in testing the plasma. Known A cells and B cells are introduced into the samples of unknown plasma, with the A cells clumping in B plasma and vice versa. Both A cells and B cells will clump in O plasma, and neither group of cells will clump in AB plasma.

The Rh type is determined by introducing anti-Rh sera into a sample of unknown cells.

700 pints in 24 hours

When the machine is on a normal work basis, three technicians will be able to test more than 700 pints in three shifts of a 24-hour period, one and a half times the amount that six technicians can now do in the working day.

According to a spokesman for the Red Cross laboratories, "The machine will not replace any technicians, who are in short supply, but will eventually allow those who normally do routine grouping and typing to devote their time to more specialized work in minor factor analysis for the Red Cross national donor registry, serological tests and studies in blood components and antibodies."

For the present, manual testing will be done on a parallel basis on all blood until it is established that complete substitution of the automatic blood sorter is fully acceptable.

THE NUCLEAR PICTURE

Nuclear accident on purpose

At Jackass Flats, Nevada, a modified nuclear reactor was deliberately destroyed at the Nuclear Rocket Development Station as a safety experiment simulating what might happen if a nuclear rocket exploded during a launch. Scientists imposed a sudden increase in power on the generator, causing a rapid release of heat and energy. This caused the reactor to burst apart. The safety experiment was designed to obtain information on the behavior of nuclear rocket reactors under a wide range of accident conditions. The test was under the direction of the National Nuclear Rocket development program.

WONDER OF THE MONTH

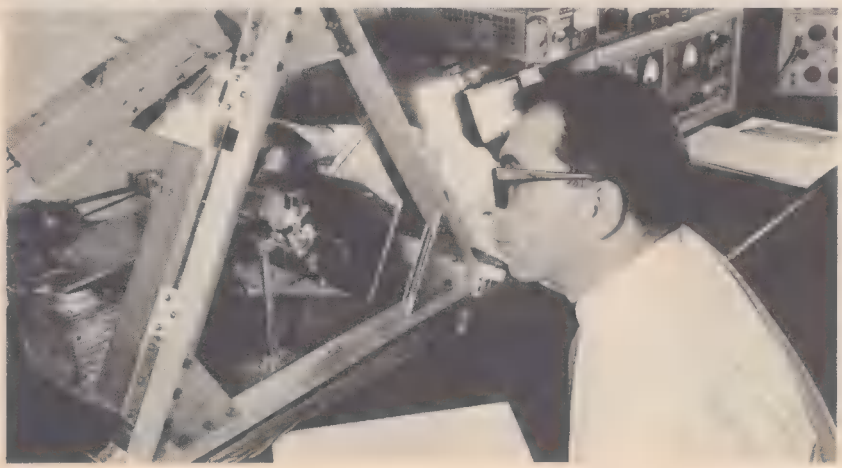
The machine that flies— but shouldn't

Above: A life-sized mechanical beetle wing, part of a device that duplicates the movement of the actual wing in flight. Below: Scientist Leon Bennett prepares the mechanical wing for a test "flight."

ACCORDING to conventional helicopter flight theory, some beetles and even certain bees perform miracles by getting off the ground. In fact, one beetle, *Melolontha vulgaris* (the English June Bug), shouldn't be able to fly at all.

Scientists at New York University's School of Engineering and Science are studying the remarkable rise of *M vulgaris*. They have built a fully-instrumented mechanical beetle wing that may teach man some new tricks about flying.

Senior Research Scientist Leon Bennett, director of the project, says that for its average weight of approximately .9 grams, the *M vulgaris* needs a lift coefficient (a mathematical measure of lifting



force) of at least two to three to fly. Yet the insect, which is defying accepted flight theory and baffling aerodynamicists, has an estimated lift coefficient of less than one.

"The most effective man-made unflapped airfoils," Bennett says, "produce a maximum of only one and one-half. Therefore the beetle wing, though it appears ineffective, apparently produces nearly twice the lift obtainable by the most effective man-made wings.

Beetle aerodynamics

"If we can determine the semi-hovering aerodynamics of this beetle's flight, we may find that either current theory is somehow incomplete in its application to insect flight or that the insect has some yet undiscovered means of attaining high lift."

For the study, the School of Engineering and Science researchers have built an actual-size artificial wing that "flies" just like its real counterpart.

Intricately linked to an electric motor, it flaps in a manner as close to actual beetle wing movement as possible. To duplicate the wing action exactly, Bennett and his associates made a long and careful analysis of a European scientist's high speed photographic studies of *M. vulgaris* in action.

M vulgaris is not native to the United States and, in fact, is a pest which the Department of Agriculture has ruled cannot be brought into this country.

This fact, plus the fragility of real insect wings, are some of the considerations which led Bennett and his group to build an experimental model.

Model beetle wing

The primary reason for the model, however, is that it gives the researchers precise control of test variables which could never be controlled in studies with real insects. For example, the flapping rate can be increased or decreased and the researchers can isolate and measure single forces in which they are interested.

The mechanical wing, which flaps down through a precise 140° angle and returns, is carefully counterweighted to change its angle of incidence automatically in the cycle just as the true beetle's wing changes its angle.

The wing is attached to a triangular frame by wires that cut through a beam of light directed into a photometer. Lift and other aerodynamic forces generated are transmitted to the wires and sensed by the photometer as shadow variations. The photometer feeds into recording and read-out equipment which enables the scientists to measure movements as small as .00001 inch.

The experiment has, of course, tickled some amateur scientists, who can't help comparing the phenomenal rise of this common English beetle with the rise of a vocal species of English Beatles.

INVENTIONS PATENTS PROCESSES

How to shoot out a fire

Grenades filled with fire extinguishing powder are pneumatically fired at flames.

A NEW portable firefighting device called Gren-Gun has been put on the market. It is a gun that pneumatically fires a grenade filled with standard dry chemical fire-extinguishing powder. It can fire a grenade accurately up to 200 feet.

After reaching the target, the grenade bursts, dispersing the dry chemical powder in a cloud approximately 10 to 12 feet in diameter and five to six feet high.

The advantage of the grenade gun is the ability to place large quantities of a fire-extinguishing agent in inaccessible or hazardous areas very rapidly.

Intended for use by professional firefighters, the gun operates from any source of high-pressure air. A standard 9-pound back pack breathing air bottle normally carried on fire engines will fire over 60 grenades from the gun.

Four grenades can be fired from a magazine in less than 10 seconds. Using preloaded magazines, two guns operating simultaneously can deliver approximately 50 pounds of extinguisher per minute, for example, through a window of an apartment, 100 feet above the ground. With a muzzle velocity of 90 feet per second, the grenade has sufficient inertia when fired to penetrate window screens and glass.

The hand-operated version of the grenade gives the same large burst of extinguisher powder at hand-tossing ranges up to 30 feet. This permits grenades to be thrown into rooms, closets, attics, compartments, etc., and within a few seconds completely fill the volume with extinguisher. The hand grenade will also be useful for dropping down chimneys, through skylights, into manholes and through basement windows.

Manufacturers are the American Research and Manufacturing Corp., 690 Lofstrand Lane, Rockville, Md. 20850.

Air surgery

A new concept in surgery, called air surgery, was introduced at a meeting of the nation's top orthopedic surgeons. The concept, and the instruments that have made it an accepted surgical technique, are the work of Dr. Robert M. Hall, Pittsburgh oral surgeon.

Air surgery replaces the saws, chisels and mallets ordinarily used in bone surgery with ultra-high-speed, air-driven surgical instruments called Airtomes (air cutting). They cut through bone and cartilage as easily as a surgeon's knife slices through ordinary tissue.

The surgeon can saw through a large leg bone, cut away the top of the skull for removal of a brain tumor, automatically drill holes and insert screws in fractured bones of the face and perform hundreds of other intricate surgical procedures.

Air surgery has made surgical techniques so precise and delicate that the surgeon can literally do sculpturing in bone. A standard demonstration is to write through the shell of a fresh egg without damaging the thin, fragile membrane that lies just beneath it.

Surgeons using the technique report that it reduces the time required for bone operations by as much as 80 percent. This means shorter periods of anesthesia for the patient. Cutting and shaping are so fast and clean that the adjacent living bone cells are not damaged by heat or crushing. Gone is much of the shock, pain and post-operative recovery time.

Dr. Hall's surgical instruments are tiny air motors driven by compressed air or nitrogen. In principle, they resemble the high-speed, water-cooled air drills used by dentists. The surgical instruments, however, are air-cooled and much more powerful, versatile and rugged.

A new drilling tool called a turbocorer brings the unprecedented 35,000-ft. Project Mohole depth closer to reality. The tool is powered by drilling fluid pumped down the drill pipe. It eliminates the need to turn the long string of drill pipe in order to turn the bit at the bottom.

Desalting water with sun

A report on more than six years of research and field evaluation on basin-type solar stills for converting sea water is expected to influence future design of such stills.

The report, which contains economic and engineering data, was prepared by Columbus Laboratories of Batelle Memorial Institute. It

discusses the design, construction, operation and maintenance of an economical solar still for localities with considerable sunshine.

The still described in the report is a shallow basin lined with waterproof material and covered with glass. Sunlight passing through the glass cover heats the sea water in the basin. Some of this water evaporates, condenses on the underside of the sloped glass cover, runs down the cover into troughs and is drained off for use.

The evaporating process produces fresh water by leaving the salt residue in the basin. Designed as a permanent installation, the still can meet a daily fresh-water need of up to 10,000 gallons.

New agricultural airplane

An agricultural airplane that squirts fertilizer, seed or pesticide rearward out of its wings was announced at a meeting of the American Society of Agricultural Engineers. This new concept of aerial application uses a separate engine to blast air backward out of a long slot in the upper trailing edge of the airplane wing. Engineers say tests demonstrate that more dry material can be spread in less time and with a better pattern of distribution.

The new wing, with internal ducts delivering a precisely controlled stream of air outward along most of its length, is designed for faster and more efficient spreading of fertilizers and other dry material.

Traffic accident lab

A computer and a closed circuit television are causing realistic traffic accidents in an effort to prevent them.

The project, sponsored by the Division of Accident Prevention of the U.S. Public Health Service and Goodyear Aerospace Corp., is part of an expanding program to study human reactions to driving conditions in a safe laboratory environment.

It involves use of a newly developed test model of an automobile driving simulator which permits research personnel to create traffic "emergencies" merely by pushing a button.

The simulator uses a television camera to scan a realistic terrain model and project its image in front of the driver. The computer moves the TV camera in response to the driver's actions behind the wheel, so what he sees in front of him is exactly what he would see on a real road.

It is even possible to create "emergencies"—such as a car darting from a side road—and then to check the driver's reaction to them.

Components of the simulation test model—in addition to the analog computer, the television system and the extremely realistic 12 by 18-foot terrain model—are a real automobile and a high-gain spherical projection screen developed by Goodyear Aerospace.

The project goals are greater understanding of behavior in traffic.

Sweeter sweet corn

Sweet corn that stays sweeter longer, and could reach Northern consumers as fresh in the winter as it is in the summer, is being developed by Pennsylvania State University scientists.

The new, higher-quality sweet corn mutant strains, in which the kernels hold their high sugar content for many days after harvest, resulted from research in carbohydrate synthesis by Drs. Roy G. Creech and John D. Loerch.

Several of these mutant strains are being developed and tested by commercial breeders and the University's College of Agriculture.

Two General Electric scientists peer at one another through the "honeycomb" of quartz ingots in the biggest fused quartz mirror blank ever made. There are more than 150 ingots in this 68"-diameter blank, which weighs more than 3000 lbs. GE received a $1-million contract to produce a blank twice as big as this one—a mirror to be 151" in diameter and weighing about 32,000 lbs. This new quartz giant will be used by the Kitt Peak National Observatory, Tucson, Arizona.

An inside view

It looks like a standard type hypodermic needle. Instead of medicine it is filled with 10,000 tiny glass fibers capable of transmitting light.

When the needle is injected into a body organ, the image of the tissue is transmitted through the optical fibers to a microscope where it is magnified more than one hundred times.

The hypodermic microscope has not yet been used on patients, but Dr. Charles Long II of Western Reserve University School of Medicine predicts that it will one day permit a physician to view deep-seated tissue without the need of surgically opening the body. Any desired length of needle can be used.

There is still a major obstacle to be overcome before it can be widely used.

Since living tissue is not stained, there is a lack of contrast which makes identification of structures difficult.

The optical fibres are grouped in two bundles, one carrying light down to illuminate the tissue, the other transferring the light reflected by the tissue back to the top of the needle for magnification and examination by doctors.

Tubes of optical fibers previously have been used for insertion into the stomach by way of the mouth or as a catheter to be inserted into the vein in order to study heart action.

INVENTOR OF THE MONTH

Furniture you inflate

Fabian Bachrach

At age 15, Milton Birnkrant invented a spring heel, for lively walking. His ambition to patent it was thwarted, however, by the discovery that this had already been done, some time in the nineteenth century.

The same Milton Birnkrant, now a doctor of medicine and director of radiology for Trafalgar Hospital in New York, has just succeeded in patenting something else, which he calls S.S.U. (for Scientific Space Utilization). It is a system of storing inflatable furniture inside the walls of a room, pulling it out, and blowing it up for use.

The patent is broad enough to cover also the storage of seats between double floors in an auditorium. When they are stowed away, the tops of the seats are designed to form a surface smooth enough to permit execution of the frug and the watusi.

Science Digest's Inventor of the Month leaves details of the hollow, flexible chairs and tables to others. He is interested in the broad problem of conserving space, whether in hotel, home, ship, aircraft, patio, house trailer or private automobile. He would make one cubic area do two or more jobs, perhaps serving as living and sleeping quarters and as a hall for the P. T. A.

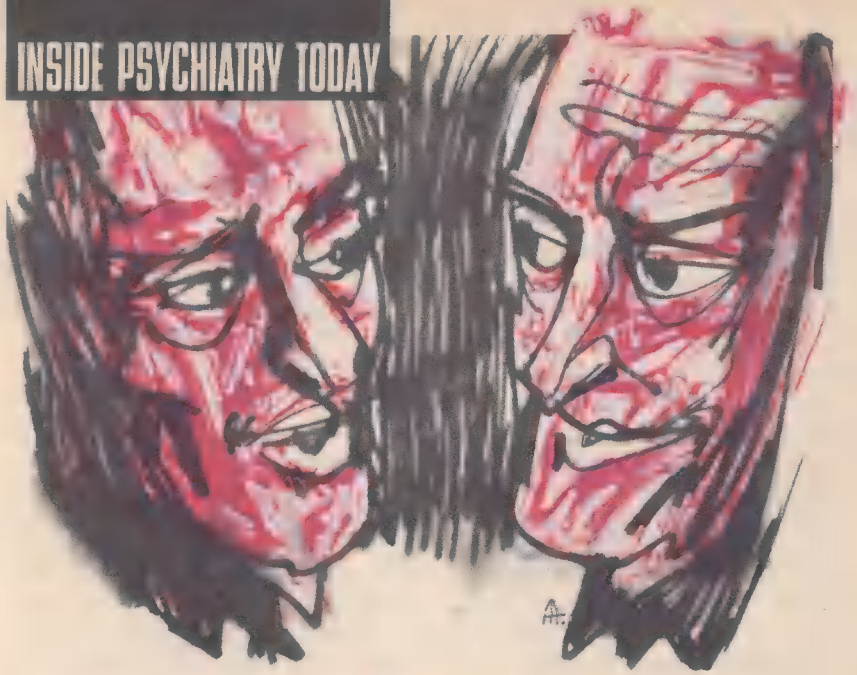
In a residence, a deflated piece of furniture may be hidden behind a wall panel. When the householder opens a valve, compressed air ejects it through an opening and it becomes a chair. Blown up further, it turns into a bed. When the pumping is reversed by applying vacuum, the object disappears.

The scheme unfolded in Patent 3,166,799 includes also inflatable walls and partitions. Dr. Birnkrant said the other day that he hoped his pioneer invention would do for inflatable furniture and structures what the tea bag did for tea, the attached eraser for pencils, the shoelace for shoes and the Murphy bed for the Murphys.

He also hopes it will do something for the Birnkrants, affording him a financial cushion so that he can devote full time to cancer research. After getting his M.D. from New York University Medical College at age 22, he served as a medical officer in the Public Health Service during World War II, and before going to Trafalgar was director of radiology at Grand Central Hospital.

His son David (7) has just invented a toy telescope.

—*Stacy V. Jones*



Your emotions are in your voice

by Flora Rheta Schreiber and Melvin Herman

EVERY speech teacher knows that your voice mirrors your emotions. Every child who complains that when Mother talks she always seems to be scolding knows this, too. So does every boss who gets the jitters when his secretary answers the phone in a strident voice.

Now, however, comes a quantitative laboratory measure of this essential truth from Dr. Arnold J. Friedhoff, a psychiatrist, and Murray Alpert, a research psychologist, both associated with the New York University Medical Center.

When these investigators analyzed the human voice electronically, they discovered that identical twins cannot be distinguished from each other by the characteristics of their sound waves, but that fraternal twins can. They observed, too, that the voices of brain-damaged patients have changes in the higher frequencies and that the detection of these changes would contribute to the physician's ability to distinguish such patients from others.

Both normal individuals and schizophrenics, it was also noted, betray emotion through changes in the lower frequencies. The higher frequencies apparently reflect sta-

The way you react to life's crises may affect your mental health. It may strengthen it or it may make you more vulnerable to mental illness.

ble characteristics of the individual, like the anatomy of his vocal tract; the lower frequencies, which may be more closely associated with muscle tension, reflect characteristics of the individual's momentary emotional state.

In a test of how certain emotional stimuli affect the voice, it was further noted that schizophrenics responded differently from other persons.

The Friedhoff-Alpert investigation springs from the observation that schizophrenic patients have what is known technically as a flat effect; that is, they show little emotional response. To find the precise characteristics that mark the voice in schizophrenics, the investigators use a device that analyzes the intensity of speech and also its frequency components.

In the tests so far conducted, schizophrenics, contrary to expectation, do show a vocalized emotional response. They appear to differ from normal persons, however, by responding to neutral stimuli in much the same way as they do to emotional ones. In other words, schizophrenics responded emotionally whether or not the test situation called for emotion.

Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

Predicting mental health

The concept that mental illness—in many cases at least—is related to such ordinary crises of life as getting married, changing jobs, having a baby, and losing a loved one, is being explored by the Harvard School of Public Health. "The way a person handles a particular crisis may strengthen his mental health and leave him better able to cope with the next crisis," believes Dr. Gerald Caplan who heads the study. "Or it may increase his vulnerability to, and even bring on, the illness."

The psychiatrist can determine, by observing how people cope with the danger and frustration of stress-engendering events, which types of coping behavior lead to a healthy mental outlook and which do not. "It should be possible to use these findings to recognize—early enough to help—the people who are heading toward trouble," says Dr. Caplan.

One of the life crises studied was the situation faced by the mother in a premature childbirth. The researchers learned to predict with great accuracy whether or not the relationship between mother and child, once the crisis had subsided, was likely to be emotionally

healthy. It was found that for the mother who visited her infant regularly and frequently during his prolonged stay in the hospital there was a healthy emotional outcome for her and her baby.

Each crisis presents a number of such tasks, and the degree to which these are mastered bears both upon the functioning of the individual and of persons associated with her.

These ideas about crises applied by nurses and other care-giving persons in a community can pave the way for stepping up preventive psychiatry. They have been used in the *Manual for Psychiatrists Participating in the Peace Corps Program* (by Dr. Caplan) and *Adjusting Overseas—A Message to Each Peace Corps Trainee* (by Dr. Caplan and Vivian Cadden).

The chemistry of the brain

The difference between smartness and stupidity may be the difference between the relative quantities of two chemical elements in the brain.

This startling observation grows out of a series of animal experiments conducted by Dr. E. Roy John, a physiological psychologist, and his associates at the Center for Brain Research of the University of Rochester.

Dr. John's experiments shed new light, too, on memory. They show, for instance, that memory has at least two main phases. For perhaps an hour after something happens, the event is only delicately recorded and can be easily erased by electrical stimulation. After that time, however, memory entering a more stable phase, becomes more difficult to destroy. The older the memory, the more deeply it seems to be impressed and the more indestructible it becomes.

A temporary hole in memory—Dr. John also has demonstrated—can be chemically produced. A small amount of potassium or calcium—less than a milligram—injected into a cat's brain, produced a temporary lapse. A cat who had been taught remembered that in order to avoid an electrical shock it had to jump across a fence when it heard a tone, forgot what had been learned after the injection. Some hours later the memory returned.

Memory is affected by the brain's chemical balance. When the calcium level is raised in the brain of a cat just *before* each training session, the animal can be taught the very response that calcium blocks in normally trained cats. About half an hour after the injection, however, the brain returns to its original chemical state, and the animal trained in the presence of additional calcium remembers the conditioned response quite poorly—unless more calcium is injected. On the other hand, when the calcium level is raised just *after* each training session, the animal will likewise learn but, in this case, after the training has been completed, an in-

The chemical condition of the brain when a particular response is being learned, is the condition in which the response is best remembered.

jection of calcium will temporarily knock out all memory of it.

On the basis of this and other experiments, Dr. John concludes that, *"the chemical condition of the brain—in particular, the calcium potassium ratio—when a particular response is being learned, is the condition in which this response is best remembered."* He speculates further that the chemical balance affects the storing of information in such a way that access to memory is easiest in a chemical environment like the one that existed when the information was stored.

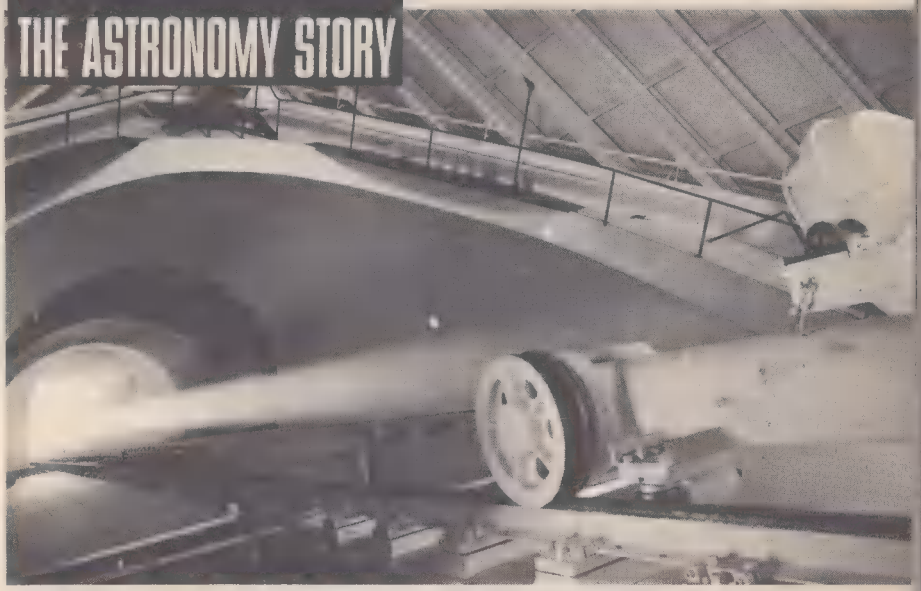
If the brain's effectiveness in receiving and storing information should prove, as is expected, to depend on the concentration of these chemicals, Dr. John points out, the finding will be significant in the treatment of mental retardation. In some cases, for example, it might be found that the blood-brain barrier was admitting too much calcium, with the result that the brain was operating at a level lower than its fundamental capability. Although there would still remain the problem of getting more or less of a particular substance past the blood-brain barrier, something about the bodily processes regulating the permeability of the barrier is now known and Dr. John believes that with further research the problem could be solved.

Electricity in the brain

Dr. John and his associates also have developed a new research tool that considerably enlarges man's ability to describe and understand the brain's operations.

The new tool, a method of analyzing electrical activity occurring simultaneously in many parts of the brain, makes use of two computers. One records electrical discharges picked up by electrodes in the brain and determines the pattern that is typical for a particular location during a particular situation. In Dr. John's work with cats, 35 locations are examined. This information is fed into a large digital computer. The end result is a series of equations describing in terms of electrical activity how the brain has been functioning. This makes it possible to count the number of discharging neurons in different areas and to relate the pattern of each area with that of each of the others. As each activity of the brain-learning involves many areas, by studying the relationships among these areas we may begin to understand the physical processes involved in learning, decision-making, and recalling events. These studies may enable researchers to describe the development of a neurosis.

THE ASTRONOMY STORY



Sunlight is reflected down the interior of the optical tunnel of the McMath Solar Telescope of the Kitt peak National Observatory. Five foot mirror magnifies the sun's image.

How to study the 'onion'

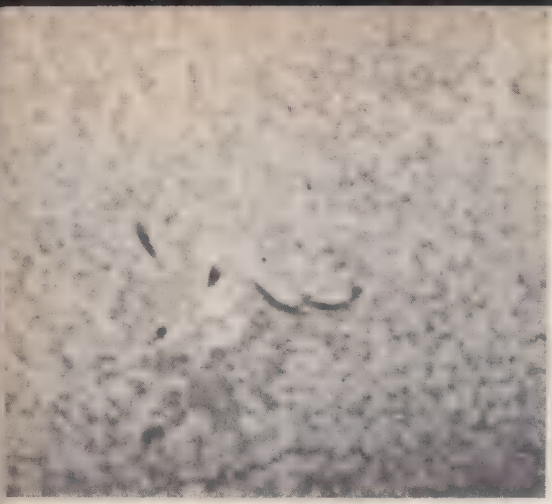
IN THE near future, a host of new and often bizarre instruments will multiply astronomers' ability to study the sun.

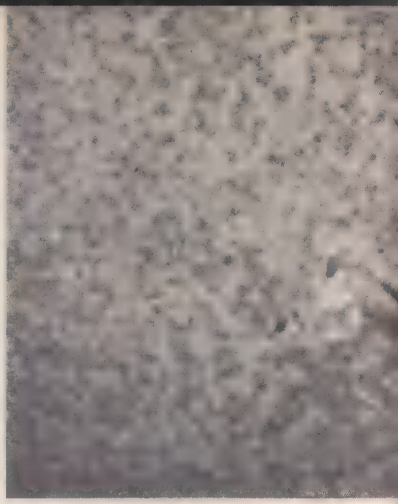
Research already has established that the sun is a great thermonuclear "onion," consisting of layers of gaseous matter, each hotter than the one above it. Its surface temperature is about 4,500 degrees Centigrade. At the deepest depth to which we can presently see, its temperature is 8,000°C. The sun's thermonuclear core is probably about 14,000° C.

What kinds of instruments will be used to probe the sun further? Here are a few:

• The McMath Solar Telescope of the Kitt Peak National Observatory, Tucson, Ariz. The giant telescope has a focal length of 300 feet. The mirrors with which it magnifies the sun's image are five feet in diameter. The long focal length and large mirrors produce a big, bright image of the sun for the light-analyzing devices in the laboratories built around the instrument.

The astronomers operating the telescope are learning how to control the temperature of the air in





A single solar event is seen with a three-color process developed by Lockheed-Calif., photographed at (left) half an Angstrom to the long (red) wavelength side of hydrogen-

the optical tunnel so that the sunlight traveling down it to the big mirror at its base will not be distorted by turbulence.

Sunlight is caught by a heliostat, focused, and reflected back up the tunnel to a room which contains the spectrometers. A spectrometer is an instrument that separates sunlight into the different wavelengths that make it up (see page 84). Heliostats are mirrors mounted to follow the sun as it moves through the sky.

A large part of the optical tunnel and most of the laboratory rooms are below ground. Part of the tunnel is contained in a concrete structure and windscreen which emerges from the ground and is supported by a concrete tower.

• Designs are now complete for a new solar telescope at the Sacramento Peak Observatory of the Air Force Cambridge Research Laboratories. The plans call for a conical tower 136 feet high containing the mirrors that bring the sun's light into the instrument and the apparatus used to analyze it. One hundred and eighty feet below the ground is the objective mirror of the instrument. The great tube connecting the two sets of mirrors is 329 feet long.

This tube will have all the air evacuated from it. If it contained air, differences in its temperature would produce distortions of the sun's image. The concrete tower supporting the telescope must remain very steady in high winds, its massive construction protecting the instruments inside from excessive vibration.

Many kinds of solar observations can be made with the telescope, but it probably will first be used mainly to study solar flares, the most exacting field of solar research today.

• Two German scientists intend to build a balloon-borne solar observatory, called "Spectrostratoscope."

By floating above most of the earth's atmosphere, "Spectrostrato-

alpha; (center) half an Angstrom to the short (blue) side of hydrogen alpha; (right) hydrogen-alpha. The process shows material moving toward, away from, or across the sun.

scope" should be able to make highly detailed spectroscopic studies of the fine features of the sun's surface that are hard to see from ground-based instruments.

• A Brookhaven laboratory physicist, Dr. Raymond R. Davis, is building a "swimming pool" full of cleaning fluid (perchlorethylene) in which to capture solar neutrinos. Neutrinos are chargeless almost massless nuclear particles which can pass through the densest matter without being stopped.

Dr. Davis' 100,000 gallon tank of perchlorethylene will give scientists their first direct look at the center of the sun. The number of neutrinos produced in the thermonuclear heart of the sun is related directly to the number of them that change chlorine-37 into aragon in the tank. This fact should give scientists information on temperature and, therefore, on other conditions at the sun's center about which they have been able only to guess.

The tank will be built 5,000 feet down in a silver mine so that earth and rock will screen out cosmic rays, which might otherwise confuse the device.

• A photographic technique has been developed that shows material moving toward and away from the sun's surface, as well as across the surface.

Pictures of the sun are taken—one at a wavelength of light called hydrogen-alpha, another at a wavelength slightly to the red (long wave-length) side of hydrogen-alpha, and a third at a wavelength slightly to the blue side. The picture at the red side shows motion toward the surface (away from the observer); the blue displays motion out from the surface.

The three pictures are printed in different colors on a single negative. A series of these three color negatives, when shown as a motion picture, displays turbulences of the solar surface in three dimensions.

THE BUSINESS STORY

Proteins from petroleum

by Bruce H. Frisch

THE CLUES were these: Tiny plants live at the bottom of oil tanks; others eat away at the undersides of asphalt roads. From them, Alfred Champagnat, director of research for a French oil company, Société Française des Pétroles BP, jumped to the inspired conclusion that he could turn petroleum into protein by feeding it to yeast.

Today an SFBP pilot plant is turning out 50 tons of protein a day. And the oil that comes out is a higher grade than the oil that goes in, which is really the job Champagnat was given to do.

The problem he faced was that one of the heavy portions of crude oil contains 10 percent wax. In cold weather the wax freezes, blocking pipes and filters. If the wax were simply removed, oil companies would be left with more wax than they could give away. Champagnat bred a strain of yeast that takes its carbon and hydrogen from wax the way ordinary plants take carbon from the carbon dioxide in air and hydrogen from water. The yeast needs two more elements, nitrogen and oxygen, to form protein. Fertilizer supplies the nitrogen as well as a few necessary trace elements. A mixture of oil, water (used as a medium), and fertilizer is beaten furiously to keep the oil and water from separating while air is bubbled through it to supply oxygen.

In two to eight hours, the yeast doubles its weight. It is extracted by a centrifuge, a machine similar to a cream separator, washed to rid it of any oily taste, and dried into a whitish powder with no flavor.

As protein, it is not as good as meat, but is better than cereals. Nutritionists rate proteins according to what proportion can be used by the human body and how complete a selection they contain of the building blocks of proteins, the amino acids. We feed vegetable proteins, the poorer type, to animals, which convert it to the better type, meat. Ruminant animals like cattle, sheep and goats can also digest the cellulose parts of plants that are inedible to humans.

The cereals that the undernourished eat instead of meat are short on several important amino acids. Therefore, British Petroleum, parent of SFBP, believes that the two main uses of proteins from petroleum will be to enrich cereals and to feed animals.

Here in the United States, Esso Research and Engineering is carrying on experimental work in Linden, N.J. Over a dozen more organizations around the world are looking into more ways microorganisms can help process oil.

Helicopter that isn't

Tilt-wing, engines and propellers pointed skyward, the XC-142A rises vertically.

Above: Fifteen feet up, as wings ease forward, the plane gains momentum. Below: With wings in a conventional position, the XC-142A can hit 430 mph.

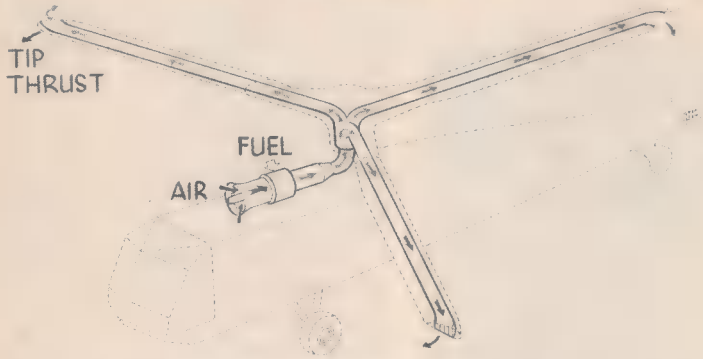
PLANES that can be flown like conventional aircraft but take off and land vertically are being intensively tested by practically every major aircraft company in the world. It is one of the hottest fields in aircraft today.

Ling-Temco-Vought, Inc. has developed for the Department of Defense the XC-142A, said to be the largest vertical takeoff and landing airplane in existence. The craft made its first transition flight earlier this year. Its performance was described as "flawless."

The XC-142A is the first craft of its type built for operational evaluation rather than experimental testing. Capable of operating vertically and yet flying at more than 430 miles an hour in level flight, the transport will carry 32 fully-equipped troops or 8,000 pounds of cargo and operate from small clearings and unprepared areas.

In the flight, with its tilt-wing engines and propellers pointed skyward, the big transport rose vertically about 15 feet off the runway. It then eased its wing forward, picked up momentum rapidly and was speeding along in conventional flight before it had flown over 2,500 feet of runway. After circling the field, it reversed the procedure, halting in the air about 15 feet above the runway and easing down vertically to a very soft landing.

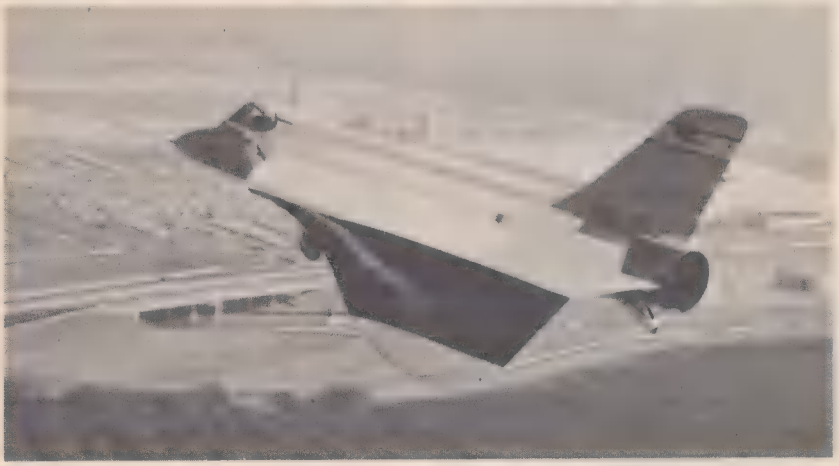
Helicopter that is



Above: How the new Hughes "Hot Cycle" helicopter works. A turbojet gas generator combines air and fuel to create hot gases which are ducted through the blades of the copter and out through the rotor tips. The rotor itself becomes the power turbine, converting energy of the gases to rotary power, allowing the craft to lift larger loads.

Right: "Hot Cycle" helicopter has louvers on the rotor tips, through which the hot gases jet forth. With the copter is Hughes chief test pilot Robert G. Ferry.

Below: Specially modified Douglas F5D supersonic jet may lead to more efficient low-speed characteristics for high-speed planes. Effect being studied by technicians is whirlpool of air seen here as a white wisp flowing over the black portion of the wing.



Row over rockets

AFTER the U.S. lands men on the moon, where are we going in space? The answer is probably nowhere, at least for some time.

The National Aeronautics and Space Administration's new budget does not contain funds for future development of rockets big enough to send men to any of the nearby planets. Of course, there is continuing development on the nuclear-electric Nerva rocket engine, but this is for the distant future.

After the Apollo astronauts land on the moon in the early 1970's (you can probably forget the often quoted line about getting a man on the moon "in this decade"), there is nothing really dramatic in the works. There will be more complicated moon shots and extended earth orbits, all of which will be of great interest to science—but nothing that will hold public attention, like sending a man to Mars.

Dropped out of the NASA plans is development of the Nova series of big, solid-fuel missiles. These could be used for manned planetary shots. Also gone is the small nuclear electric system, SNAP 8, which would have had ultimate application in unmanned satellites.

The Manned Orbiting Laboratory is now completely in the hands of the Department of Defense. If the military decides manned strategic reconnaissance from space is useful, it may be pursued. But NASA, which once seemed to control the MOL, has nothing to do with it.

Dr. Robert C. Seamans, Jr., NASA Associate Administrator, admitted at a budget briefing late in January, "The Saturn V (the Apollo rocket) would not have the capability to handle that mission (sending a manned flight to Mars) because we would have to have at least of the order of one and a half million pounds in Earth orbit as a taking-off point to go to the planets. This would involve, as you can see, a very large number of rendezvous using the Saturn V. We don't believe that would be a good approach."

What has happened is that the Johnson Administration had decided to keep NASA's budget pretty much the same as last year. Programs like the manned moon shot, to which we are deeply committed, will be continued. But no extensive (or expensive) new programs will be undertaken, at least for the present.

Since Sputnik, an ever-increasing NASA budget has seemed inevitable. Now, however, a number of powerful factors have combined to result in a slowdown.

First there was President John-

son's decision to keep the Federal budget close to $100 billion. Into this budget had to be fitted such costly new programs as the war on poverty and increased Federal aid to education.

Another factor was the cost of past space programs. Project Mercury far exceeded its original cost estimates, and Gemini bids fair to do the same. Members of Congress and the Administration want to examine all projects more closely.

Decrease in Russian pressure

A third factor is a decrease in pressure from Russia. Aside from their only partially successful, three-man orbital flight of 1964, the Soviets have not done anything dramatic in space recently.

One other influence is the criticism of many scientists of the enormous drain in money and scientific talent of the space program. According to these critics, such resources could be put to better use in basic research or programs for social improvement on earth.

Then, too, there are some hard scientific problems, particularly in regard to manned spaceflight. Space biologists are really worried about the effects of prolonged weightlessness, and want to learn more about it before sending a man off to any distant planets.

With a smaller pie to divide, internecine warfare has developed within NASA, between the Office of Manned Space Flight and the Office of Space Science and Applications. Dr. Homer A. Newell of Space Science and Applications wants an unmanned landing on Mars to be the next major NASA objective after the moon landing.

Dr. George E. Miller of Manned Space Flight, on the other hand, argues that man makes a unique and essential contribution to any space exploration.

Manned spaceflight is more expensive and needs bigger boosters and thus will probably suffer more in the slowdown.

Aerospace companies who had come to take ever-expanding budgets as a way of life are squealing, especially those whose research programs are being "phased out." With determined optimism, some trade magazines are saying that the slowdown is only temporary, and soon R&D budgets will be spiraling again. Other observers see a semi-permanent ceiling on spending, and some aerospace companies are looking for earthbound tasks for their personnel and facilities.

A dramatic event, like a Russian space spectacular, might change the picture. But the public and Congress are pretty hardened to this sort of surprise, and even a quick Soviet moon landing would probably not loosen the purse strings for new "crash" programs.

And this month, of all months of the year, Government proposals to hold the line on spending will be sympathetically received. For after we face up to our taxes on the 15th, an American on Mars will not look nearly as glamorous.

TIPS AND TRENDS

WE'RE GETTING HEALTHIER, BUT...In 20 years' time, the following nine diseases may have been wiped out: diphtheria, whooping cough, polio, tetanus, rabies, measles, typhoid fever, syphilis and gonorrhea. We may also have found a vaccine against leukemia; new cures for hepatitis; artifical hearts and new, small kidney machines; ways of eliminating tooth decay and controlling gum disease, and drugs to allow home care of most mental patients. So reported Dr. Luther L. Terry, U.S. Surgeon General. The following day, the Pitman-Moore Division of Dow Chemical announced the licensing of a new live-virus measles vaccine given in one injection and said to be 99 percent effective. The "but": From Dr. Marcolino G. Candau, head of the World Health Organization, came a warning that, despite scientific progress, "health services are not keeping pace" with the growing population.

WANT TO WIN $1,000? That's the first prize in the 16th annual competition for the best essays on gravity. They must be typewritten, double-spaced, in English, with two carbon copies and a 100-word summary on a separate sheet. Address:Gravity Research Foundation, New Boston, N.H. Deadline: April 15, 1965.

HOW TO MAKE A DOLLAR IN SPACE: 1. Design a Voyager spacecraft to explore Mars in '71. California's Jet Propulsion Laboratory has been considering industrial proposals for a three-ton capsule that would land on the planet and seek signs of life. 2. Put together a head-and-shoulders dummy that can speak and hear electronically. Houston's Manned Spacecraft Center wants one to evaluate the effect of noise levels during a space launch. 3. Deliver NASA spacecraft ahead of schedule. McDonnell's Gemini contract has been revised to provide profit incentives for outstanding performance and control of costs as well as punctuality.

MEDICAL TRENDS TO WATCH. One is positive: bloodless surgery by means of a plasma-arc scalpel adapted from a generator developed at Columbia U.'s Electronics Research Laboratories. One is negative: the marketing of pharmaceuticals that can do harm as well as good. The Food and Drug Administration reported finding some drugs with penicillin contamination that could be harmful to people with a penicillin allergy. And "Medical World News" said a virus that causes cancer in hamsters has been found in adenovirus 7 vaccine, used for a respiratory disease.

THE COMMERCIAL ATOM. Nuclear energy is now well on the way to being profitable. A Chicago power company ordered a 700,000-kilowatt atomic power plant from GE, by far the biggest yet. Some 50 other utilities are interested, according to GE and Westinghouse. It looks like the turning point in eight years of efforts to sell nuclear reactors. Big reason: competitive costs.

How Abu Simbel is being saved

The high dam at Aswan will provide much needed water for Egypt, but will flood many ancient monuments in Nubia. The greatest, the temples of Ramses II at Abu Simbel (right), have led to the biggest job of salvage ever undertaken.

by Karl Heinz Martini

THE salvage of the Abu Simbel temples is now fully under way. Yet less than two years ago, the prospects for their preservation had become very uncertain. The famous lifting project conceived by the Italian firm Italconsult had to be abandoned because of the high cost of the operation. The United Arab Republic and Unesco searched for a less expensive method.

The Government of the U.A.R. finally decided in favor of a salvage project to cut the temples into blocks conceived by the Swedish en-

Reprinted from *The Unesco Courier*.

Pictures by Hamilton Wright.

Area to the front of the Great Temple of Abu Simbel resembles a huge construction site. Giant cranes, steel girders, tons of sand and corrugated metal are all protected from the Nile by the cofferdam.

Rameses II, living God-King of ancient Egypt, sits in the company of his fellow gods in the "holy of holies," a rock-hewn chamber deep in the mountain.

gineering firm Vattenbyggnadsbyran of Stockholm.

Agreements for the execution of the project and for international participation therein were concluded between the donor states and between Unesco and the U.A.R.; the government of the U.A.R. signed the contract with the joint venture on November 16, 1963, and the work began immediately. The project is to cost between $32,000,000 and $36,000,000.

Since it had proved impossible to envisage transporting each temple as a single whole, the principle now applied involved dismantling and cutting the monuments into blocks of no more than 30 tons in weight, transporting these blocks to a position in the neighborhood of the original site but higher up, and reassembling them on that location.

This very difficult operation is being carried out in three stages: First, the hills containing the temples must be excavated so as to expose the buildings themselves. Secondly, each monument must be cut out; the blocks must be transported with every possible precaution to prevent damage and temporarily stored until all have been removed. Thirdly, the temples are to be reerected at the new site with the same orientation as before, and their surroundings must be reconstituted so as to give them, as far as possible, the appearance they had originally.

The ground level of the Great Temple of Abu Simbel is 122 meters above sea level (a meter is just over a yard) and that of Queen Nefertari's Small Temple is only 120 meters. This meant that the water level of the new High Dam reservoir, which began to fill in 1964, would flood the temples before they could be removed.

In order to shut the temples off from the rising water, a special cofferdam has been designed and top priority given to its construction. The cofferdam is about 360 meters long starting from a point south of the Great Temple and rejoining the cliff to the north of the Small Temple. When completed, the cofferdam will be about 135 meters above sea level.

Karl Heinz Martini is a member of Hochtief A. G. of Essen (Fed. Rep. of Germany), the firm directing the dismantling operations at Abu Simbel.

Above: An architectural rendering of the Great Temple of Rameses II, illustrating the inner temple and corridors extending a distance of two hundred feet into the sandstone mountain. Below: Diagram shows the present temple location endangered by the rising Nile, and the site where the Temples of Abu Simbel will be re-erected, 64 meters higher and 180 meters farther inland. The project is to cost about $36,000,000.

When the Abu Simbel temples are re-erected at the new location, modern technology will have achieved a feat rivalling their construction.

The building of the cofferdam took on a particularly dramatic character in the autumn of 1964 because the season of the flood water level of the Nile proved to be exceptionally long. It was necessary to complete the cofferdam above the level originally scheduled, and the crews found themselves working both day and night in order to reach the needed height in time. Meanwhile, several pumping stations have been installed to serve as a de-watering system for the area between the temples and the cofferdam as the water level of the Nile rises. The water is to be directly discharged into a drainage pipeline.

All work on the cofferdam will have been completed before summer 1965. The reservoir level will rise above the cofferdam in January 1967, but the monuments will have been removed long before then.

The hill above each of the temples (rising 30 meters above the top of the Great Temple and 40 meters above that of the Small Temple) is to be excavated to within 2½ feet of their ceilings and around the sides of both monuments. This means removing approximately 300,000 tons of rock.

The excavation will be carried out by means of rippers, pneumatic hammers, compressed-air drills and rock chisels. A chute at either side of each temple will bring down the excavated material, which is being used to help fill the cofferdam. No explosives can be used in this operation; they might damage ceilings, walls and statuary, which already show cracks and fissures in certain places.

At the same time, scaffolding is being put up in all the rooms of both temples in order to support the ceilings and the sides when they are separated from the surrounding rock. A huge tube is to be installed to give passage to the entrance of each temple while sand is filled above the facades to protect them.

Some of the sandstone at Abu Simbel is extremely fragile, and it will be strengthened by the injection of chemical agents. A specialized firm is now testing the different synthetic resin products to be used for this purpose. Not only must some of the blocks be strengthened as a whole—the sandstone sometimes shows so little cohesion that the blocks would break apart when cut or lifted—but the edges of inscribed surfaces must be specially treated along the cuts to safeguard against corners breaking off during cutting. The stone hooks for the lifting of the blocks will be sunk into the blocks with a synthetic resin compound.

In parts of the hill outside the immediate temple area, tests are being performed to ascertain the

exact results of each different type of cutting equipment: wire saws, disc saws, chain saws and several types of hand saws.

Only after all the tests are completed will the actual cutting and lifting of the blocks themselves be undertaken. At this stage cutting will be executed under the constant surveillance of archaeologists. Every precaution is being taken to prevent aesthetic damage being done to the monuments.

Block by block

For each temple, two guy rope derricks capable of lifting 20 to 30 tons will remove the blocks as they are cut out on trucks of a special type which will transport them to the storage area behind the old site and near the new position to be occupied by the temples.

The blocks to be removed in both temples total 15,000 tons (11,500 tons for the Great Temple and 3,500 tons for the Small Temple). In view of the need to preserve some of the surroundings of the monuments, several thousand more elements of smaller dimensions will also be taken away. The blocks will be stored with individual protective coverings and numbering to determine their exact positions in the edifices, until the transfer is completed.

The temples will be re-erected in a position about 64 meters higher and 180 meters farther inland from the river as compared with the present site. The re-erection operations will be similar to the dismantling, only in reverse order. At first, the blocks will be assembled upon an internal scaffolding, individual blocks being anchored to or suspended from a reinforced concrete supporting structure on the top of which concrete domes will be constructed to carry the overlying rock. The facades of the temples will be put up at the same time as the reinforced concrete domes.

Afterwards, the surrounding area will be landscaped and treated so as to recreate the original appearance. The orientation of the temples will be the same as before. The whole operation is scheduled to be completed in six years from start to finish.

Arduous organization

The organization of the work yards at Abu Simbel is almost as arduous a matter as the salvage operation itself. In the first place, the project is being carried out in a very remote area. Abu Simbel is 175 miles from Aswan and nearly 1,000 miles from Alexandria. Equipment which must be imported from foreign countries takes a considerable amount of time to reach the site. Moreover, the Nile is now closed by the Aswan High Dam and equipment usually transported by river must at this point be taken overland.

At present, some forty foreign and ten Egyptian technicians and 750 local laborers are working at the site. At the peak point in the

operation it is expected that there will be at least 50 foreign and 40 Egyptian technicians and about 800 laborers.

Climatic conditions are naturally very severe for everyone, but are particularly difficult for staff of European origin. However, special housing is now being provided for laborers and staff.

European staff are generally sent out to Abu Simbel for two-year periods. Abu Simbel has become a veritable Babel of languages where Arabic, German, Swedish, Italian, French, English and Spanish are to be heard.

The men who are working on the Abu Simbel project, most of whom knew nothing about the temples, their history or their cultural value before going there, are all vitally interested in making this difficult project succeed, and they have become fascinated with the history and art of the cultural treasures that they are helping to preserve. When, on the new site of the Great Temple, the first rays of the sun penetrate into the inner sanctuary exactly as before, modern technology will have achieved a result rivalling that of the ancient Egyptians themselves, of which not only those who have directly worked to make such a gigantic achievement possible, but the world as a whole can be justly proud.

"He may not have been a great Pharoah, but he was a modest one."

Some current microelectronic devices (from left to right): A "molecularized" TV camera weighing only 27 ounces and intended for space and military applications; a wafer-like "thin film" electronic circuit, which is 10 times as thick as the blonde hair stretched lengthwise across the picture; a tiny computer for space probes and earth satellites; $10,000 worth of Microglass single-unit diodes, contained in just one champagne glass.

Coming: two-inch TV

A television set small enough for you to wear on your wrist is just one of the miniature gadgets promised by microminiaturization. Here's the why of this amazing new trend in electronics and how it will spawn an array of new products.

by Stanley L. Englebardt

TODAY you can buy an AM radio about the size of a pocket watch, but one manufacturer is working on a model that will fit into a ring.

TV sets have long since shrunk below the dimensions of the proverbial breadbox, yet several firms are developing receivers (minus the picture tube) no bigger than a Graham cracker.

Present hearing aids are all but invisible; nevertheless, two companies recently announced "dramatic size reductions." Several missile guidance systems — already unbelievably compact — were reduced by more than 50 percent just within the past few months.

What's behind this race for microminiaturization, behind the almost frantic efforts to shrink components until even a transistor looks huge by comparison?

The answer is found in one word: *reliability*.

These new components do a lot more than just reduce the size of a product. For one thing, they lower the number of active components in a circuit by integrating the function of many transistors and diodes into a single tiny block of material. Secondly, they eliminate many passive elements and interconnections by sealing them into the same block. Finally, they lower warm up time and increase switching speeds simply by shortening the distance over which an electronic impulse must travel.

One way to get an idea of these improvements in action is to look at a missile. Missile reliability is a hotly debated subject these days.

Space-age devices have made the biggest use of microelectronics so far. Before long, the tiny circuits will be common in consumer products.

Many factors, of course, are involved in delivering a missile to its target. But the functioning of its electronic components is at the top.

The probability that an electronic circuit will perform as intended is usually calculated by multiplying together the reliability of its separate components and connections. As an example, suppose you had a very simple circuit made up of two active components and two soldered connections. Previous testing had shown that each of these elements could be expected to operate as intended at least 90 percent of the time. Thus, by multiplying them together (0.9 x 0.9 x 0.9 x 0.9) we get an overall system reliability of 62 percent.

Of course this is simplifying the problem tremendously. In a real missile you'd have thousands of circuits and possibly millions of individual components, all with varying degrees of reliability. Some may be expected to work virtually 100 percent of the time; others somewhat less. But you try to "make up" for possible failures by including redundant components and circuits installed for the sole purpose of taking over a job should the prime circuit go "down."

Nevertheless, missiles do blow up on their launching pad . . . they do go off course . . . they do fail to separate . . . they do miss their target. One reason is that there just isn't enough space available in the "bird" to duplicate (or triplicate in some cases) all systems. As a result, a single broken connection on a faulty transistor can spell *finis* to a multi-million dollar rocket.

This is where microelectronic (sometimes called "integrated") circuits come in. Not only do they allow for more redundancy, but the tiny circuits actually are subject to far less malfunction than the bigger ones they replace.

An example of this is provided by some recent changes in the Minuteman missile. The silo emplaced Minuteman is one of the most vital cogs in our strategic defense machine. The Air Force directed the Autonetics Division of North American Aviation, associate prime contractor on the guidance and control systems of the Minuteman, to find means for increasing its reliability, range and accuracy.

As far as range and accuracy are concerned, these can be increased by doubling the power of the missile's guidance computer. But what does this do to reliability? The original Minuteman computer contained some 89 four-by-eight inch circuit boards. Boosting capacity to meet the Air Force's requirements meant adding at least 20 more boards. And this, in turn, added

to the connections which could be broken, the transistors which could burn out and the overall weight and size of the missile.

The solution was to use semiconductor microcircuits. Wherever possible, in the flight controls, inertial platform and guidance computer, tiny integrated circuits were substituted for bulkier transistorized components. In the computer alone, one of the integrated packages was equal to 18 of the original circuit boards. As a result, the power of the guidance system was increased substantially—at the same time the size of the computer was decreased by almost 50 percent.

Space age devices

So far the biggest application of microelectronics has been in space age devices. New guidance computers developed by IBM, Sperry Rand, Westinghouse and Texas Instruments are already orbiting the earth, on their way toward Mars, or just sitting poised in the bowels of powerful defense missiles. One new computer, designed by Texas Instruments for the Air Force, is actually 150 times smaller and 48 times lighter than the device it replaced.

It is only a matter of time, though, before microcircuits will be widely used in consumer products. Even now prototypes of radically new consumer devices are humming away in industrial laboratories and are being tested out first as military or space products.

One example is the tiny molecular electronics television camera developed by Westinghouse for use in satellites. Molecular electronics is the technique of integrating into a solid block of material all the functions previously carried out by a battery of transistors, diodes and the like. Using just 36 of these blocks—plus microelectronic peripheral components—Westinghouse has built a 27 ounce camera measuring only seven-and-one-half inches long, two inches wide and three-and-one-quarter inches deep. Even so, the company feels that additional work could result in up to 50 percent more size and weight reduction.

It doesn't take too much imagination to see where this might fit into the consumer side of things. Several manufacturers are already talking about reasonably priced home television systems which would monitor the front and back doors, baby's room and similar locations Then again there's the use of television as we now use home movie cameras. The enthusiast could "shoot" his family with a tiny camera and record the images—in color, of course—on an equally small video tape recorder. Sound fantastic? Yet right now such a system is under development by at least two electronics firms.

In medicine we have several unique microelectronic devices already in use—and many more in the labs or on the drawing boards. One that has been given widespread publicity is the "radio pill" de-

What comes after ring-size radios and wall hung TV sets? The answer seems to be: You name it and the electronics industry can produce it.

veloped by Dr. Vladimir K. Zworykin. It consists of a sensor, transmitting station and power cell, all contained within a gelatin capsule. The patient pops the pill into his mouth, washes it down with water and, within seconds, it begins broadcasting from his stomach. For the next hour or so a play-by-play account of what's going on within the gastrointestinal tract fills the nearby airwaves. This "program" is picked up by a receiver on the doctor's desk. In the cryptic language of electronic beeps and tones it reveals the varying shades of acidity and pressure in the stomach and intestines. Later the transmitter is recovered, sterilized and put into a new capsule for use by other indigestion sufferers.

Amazing as this pill seems right now, it is only the beginning. Medical technicians are already working on a tiny experimental television camera which will be literally lowered down the alimentary canal to view suspected trouble spots inside the human body. Thus the video portion of the "great internal drama" will be added to the audio.

Microelectronics is also proving to be a boon for the disabled. At the Massachusetts Institute of Technology's Lincoln Lab, engineers recently built a radar set about the size of a flashlight which will enable the blind to "see" where they are going. And in the Soviet Union researchers are using microelectronic components in an artificial arm so that the wearer can use electrical signals of nerve ends in the intact shoulder to move the fingers of the prosthetic device.

In industry the big plus of integrated circuits is smaller, faster, more capacious and less expensive electronic digital computers. IBM, RCA and Control Data, among other computer manufacturers, are presently producing microelectronic models (see *How to Pick a Computer,* page 75).

The most exciting aspect of the new technology, however—at least to the man in the street—is the advent of even smaller television sets, radios and similar appliances. Although portable TV sets weighing less than eight pounds have been available for some time now, one U.S. manufacturer is presently working on a model in which the entire circuitry—minus the picture tube—is contained on a board about two inches square. Next step is reduction of the picture tube to nothing more than a flat sheet. When this happens, probably before the end of the 1960s, we will have TV sets that hang on the wall like a picture.

Also on the horizon is a flat picture "tube" compatible in size with the two-inch-size circuit board.

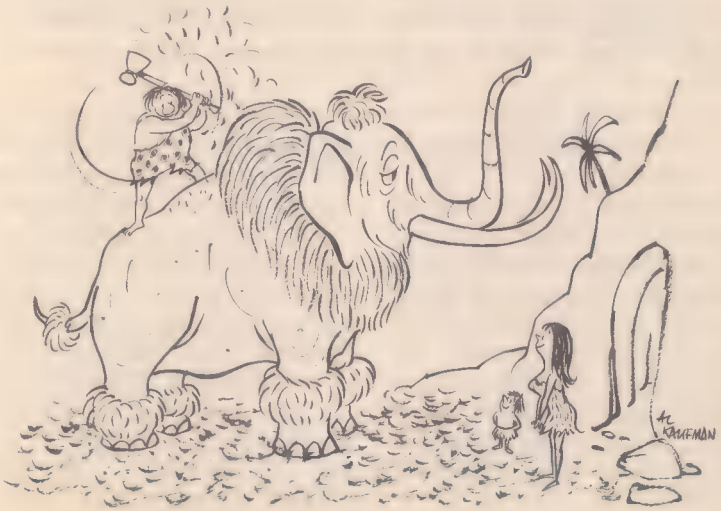
When that comes, perhaps in the near future, it won't be long before we have pocket TV or even a set you could wear on your wrist.

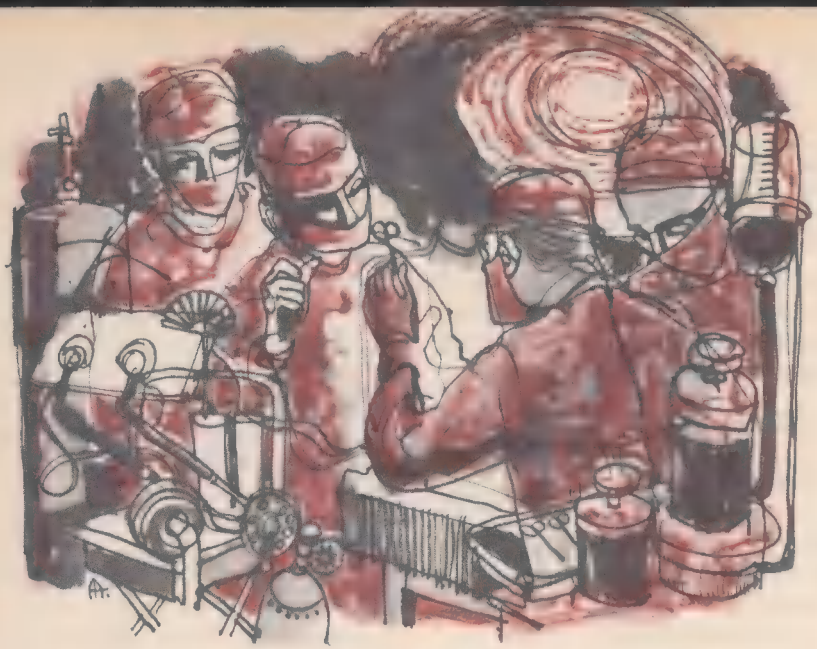
Radios are already amazingly small, yet several microelectronic models developed for the military make present consumer sets seem bulky. Westinghouse, for example, has an experimental molecular receiver about half the size of a man's finger. And, the state of the technology being what it is, the promise of a Japanese manufacturer to produce an AM radio compact enough to fit in a ring should soon be realized.

What comes next?

The answer seems to be: You name it and the electronics industry will produce it. A Dick Tracy two-way wrist radio? Something along these lines has already been developed for the Army—and soon will be applied to civilian applications such as communication between doctors and hospital. Portable (and powerful) radar units? The Air Force is presently testing a light weight, highly reliable radar which can be easily carried by a man behind enemy lines and quickly set up to detect and transmit information concerning low flying aircraft or troop movements. An electronic heart or kidney to replace a diseased one? Being tested in animals right now.

There's no doubt that some things are getting smaller and smaller. But as they do, their reliability goes up. And that is what counts most.





How to delay death

Soviet medical scientists have been able to revive dogs and monkeys that have been "dead" for hours. Here is a report of their work.

by Prof. Vladimir Negovsky, M.D., and Valentina Soboleva

THE discovery that transition from life to death is a more or less lengthy process makes obsolete the ancient conception of death.

According to the modern concept, the process of dying is divided into two main phases—clinical or apparent death and biological death. Biological death is only considered to have occurred when irreversible changes in the organism lead to the disintegration of vital cells and tissues. Much of the change in the concept of death results from improved methods of reviving apparently dead organisms. Of course attempts to reanimate animals and men on the point of death or immediately afterwards are recorded in both ancient and medieval medicine, but only in the last fifty years has a whole new branch of medicine—reanimatology or the science of organism resuscitation—been developed.

Permission : *Discovery*, London

Research into the mechanism of death has shown that it is not a momentary leap; biological death with its irreversible damage to vital organs does not occur immediately. Instead there is a lapse of time during which the metabolic processes continue at a low level. During this period of clinical death, the organism can still be revived using special methods, although when the lungs and heart cease to function metabolic processes continue under great difficulties in the absence of oxygen. The starved cells of the body cannot live for long under these conditions and the finer and more complex their organization the shorter the time for which they can survive before finally dying.

The most highly organized cells are the nerve cells of the cortex of the brain. At normal body temperature, these cells can survive complete arrest of the circulation for not more than three to six minutes, after which they disintegrate and the organism loses the last of its vitality, and the capacity to react to the most effective methods of reanimation.

How can the process of death be delayed so that the period of clinical death, during which reanimation is still possible, can be prolonged?

One way is to create an artificial circulation once the heart and lungs cease to function. Closed-chest cardiac massage, combined with artificial respiration, is the simplest method of maintaining the circulation for a considerable time, even before a doctor arrives. With medical supervision, perfusion devices such as the heart-lung machine which takes over the work of the heart can be brought into play, but this apparatus is very complicated —it takes a long time and a great quantity of blood to set the machine in operation.

Another method is by hypothermia or general cooling of the organism, usually combined with narcotic sleep. Low temperatures reduce the vitality of organs and tissues and delay the processes leading to biological death by slowing down the metabolism of the body. In the Soviet Union, experiments aimed at prolonging the period of clincical death were begun about ten years ago in the Laboratory of Experimental Physiology for Resuscitation, of the Academy of Medical Sciences.

Complete draining of an animal's blood followed by reanimation after 5-6 minutes of clinical death is typical of experiments which we conducted in our laboratory to study the processes of dying and revival of the organism.

In our early experiments with reduced temperatures the animal was cooled to 25-26° C and then we began lethal draining of its blood. Re-animation was begun 15, 20, 30 and even 60 minutes after the heart and lungs had stopped working. However, the vital functions of these animals were restored in the same way as those of animals which had been revived after 5-6 minutes of clinical death at normal body temperature.

Six hours after she "died," the baboon Kefa grabbed a penicillin syringe from the doctors and began running around the room with it.

After a great number of experiments with dogs we decided to use a more highly organized animal, the monkey. The following describes an experiment performed in Sukhumi (Caucasus) by the Institute of Experimental Pathology and Therapy.

The animal—an eight-year-old female baboon called Kefa—was given a narcotic before cooling. As soon as the monkey was asleep, we surrounded her body with ice-bags and began checking her body temperature. When it had dropped to 27°C we began draining blood from an artery. Her blood pressure decreased gradually and an hour later both the heart and respiration stopped; clinical death set in. After 20 minutes in this state when the baboon's temperature had dropped to 23.7°C, we began to reanimate the apparently dead animal. We pumped blood into an artery in the direction of the heart and at the same time started artificial respiration. After one and a half minutes the animal's heart became active once more, after fifteen minutes, spontaneous respiration began, and after four hours Kefa opened her eyes and lifted her head. After six hours, when we tried to give her a penicillin injection, Kefa seized the syringe and began running with it around the operating theater. Her outward appearance and behaviour differed little from that of a healthy animal.

Prof. Vladimir Negovsky, M.D., is Director of the Laboratory of Experimental Physiology for Resuscitation, at the Academy of Medical Sciences of the USSR—he founded this laboratory in 1936. During the war he headed a front-line team for treating casualties in advanced stages of dying. Valentina Soboleva, M.Sc., is a research worker in his laboratory.

Clinical death prolonged

These and other experiments showed that clinical death, caused by acute loss of blood, could be prolonged in monkeys by 20-30 minutes, and in dogs by one hour, by moderate hypothermia—with body temperature of 26-20°.

We found that after these periods of clinical death the vital functions of the animals could still be completely and definitely restored. In our studies monkeys proved more sensitive to the cessation of circulation than dogs, even after cooling. After 20-30 minutes of clinical death the vital functions were restored only in some of the experiments with apes, while all the dogs were revived. On the other hand, monkeys recovered from the experiment more quickly than the dogs. Dogs did not completely recover until the second or third day after 30 minutes of clinical death, while monkeys reacted actively to the en-

vironment six to eight hours after being revived.

When we gave a reanimated monkey some tangerines, it chose the sweet ones and threw away the sour ones, and when we offered candy, it chose varieties that had been favorites before the experiment. Thus although the monkey's brain is more vulnerable to injury than the dog's, it seems able to compensate for, and resist the processes of dying far more than that of the dog.

Since we know that nerve cells are particularly vulnerable to the processes of death, it is important to test them for any damage after death and hypothermia.

We established, through a great number of experiments, that as the temperature is lowered the cells of the cortex and other tissues become more resistant to the effects of death. This led us to suppose that the period of clinical death could be prolonged by even lower body temperatures. Similar experiments to that with Kefa were once more performed, only this time the temperature of the experimental animals (dogs) was reduced to 10-12° above zero—deep hypothermia.

Heart and respiration cease

The dog was first given an anaesthetic, and cooling began as soon as the animal went to sleep. When the body temperature had dropped to 20°C, blood was drained from the artery until the heart and respiration stopped. The heart ceased to beat 12 minutes after we began draining the blood, respiration stopped soon after and clinical death set in. During this period, which lasted two hours, the animal's body temperature dropped to 10° above zero.

Resuscitation

After keeping the animal for two hours in this state we began resuscitation. To restore the heart's function and body warmth we pumped fresh, warm donor's blood into an artery and let it out immediately through a vein. In addition to this artificial circulation we started artificial respiration. In the early stages of resuscitation, there was some heart fibrillation in the form of non-coordinated, sluggish contractions of individual heart muscle fibres. When the dog's body temperature had risen to 16°C above zero, we stopped the fibrillation by passing a high tension current through the animal's thorax. On the 15th minute of the reanimation period the dog's heart started to beat but, because the body temperature was still low, fibrillation recurred at later stages of the resuscitation. However by the 32nd minute, with the body temerature at 18.5°C, the dog's heart began to beat normally and the animal took its first breath. Respiration then became gradually quicker and deeper. Eye reflexes were restored after an hour and a half, and hearing after 20 hours. On the third day the animal's eyesight was re-

"We also aim at restoring the brain even after irreversible changes leading to death have begun," say the authors. Tests "give us hope."

stored and it tried to walk, but its gait was still unstable. However, by the seventh day the dog had completely recovered after a period of clinical death safely extended to two hours by deep hypothermia.

Body temperature lowered

Could the body temperature be dropped still lower without injuring organs and tissues, and could the animal be completely restored to normal afterwards? This would be equivalent to preserving the organism.

Descriptions of the reanimation of frozen men who showed no signs of life have been recorded. In this connection I will describe a case which appeared in the Soviet press.

Vladimir Kharin, tractor driver on a farm in Tselinny Territory, was caught in a snow storm and his tractor stopped. For two hours he tried to repair it, working with hands numb with cold until his strength gave way. The engine refused to work. Kharin started back on foot to the state farm, which was about 10 kilometers away. He kept falling into snow drifts and finally collapsed exhausted. His last thought before losing consciousness was that he was only 23, had a wife and daughter, and wanted to live.

On the morning of March 26 in 1960, a crew of workmen from the Yaraslavsky State Farm in Aktyubinsk Region found the body of Vladimir Kharin lying in a snowdrift. He seemed dead, his frozen fists were tightly clenched, his stiff body sounded hollow and wooden against the floor of the truck where he was laid, and his eyes, covered with a film of ice, were glassy. However, he was taken to a hospital and examined. Both heart and respiration had stopped, his pupils did not react to light, but his skin, instead of the usual corpse-like pallor, was a bluish-purple color, and there were no signs of putrefaction. Thus it seemed that he might still be in a state of clinical rather than biological death and therefore an attempt was made to save him.

Man revived

Kharin's feet were placed in warm water to dilate the vessels, his arms and body were rubbed with alcohol, and adrenalin was injected into the heart muscle to stimulate heart activity. Blood was pumped into his arteries, followed by artificial respiration when the tissues had become softer. After 40 minutes he began to revive, his skin became warm and his pulse could just be detected. More blood was pumped into the artery, the patient was laid in a sterile bed and warmed

with hot water bags. Consciousness returned 12 hours after the patient had been admitted to the hospital, and he was able to answer questions. It appeared that he had lain three hours in the snow. After several months in the hospital, Kharin recovered sufficiently to return to his job.

This interesting case does not appear incredible. We know that life can be restored after two hours of clinical death if the body temperature is reduced to 10-12° under special conditions, particularly narcosis. Since Kharin was frozen, he was in a state of deep hypothermia.

When he lost consciousness, his breathing became slow and superficial and carbon dioxide would tend to accumulate in his blood. This is the very narcotic which has been used in experiments to cause artificial hibernation in warm-blooded animals. In addition one must consider that although Kharin lay in the snow for about three hours, he may not have been in a state of clinical death for the whole time. The actual period may have been, say, two hours or an hour and a half, and until then his heart may have continued to beat weakly.

Judging by this example, the use of hypothermia in the clinic looks very promising. In cases when the patient's heart and respiration stop during a difficult operation in which hypothermia is applied, reanimation will evidently be possible after periods of clinical death considerably greater than five to six minutes.

Resuscitation is not the only aim; the revived organism must regain complete health. At the present a great deal of experimental work is centered on this problem. We also aim at restoring the brain even after irreversible changes leading to death have begun. Experiments made on animals in our laboratory give us hope. After 10 minutes of clinical death the apparently unviable organism of a dog was cooled to 30°-33° (moderate hypothermia) and kept at this temperature for two days. The higher areas of the brain were later fully restored. We found that, in the period of restoration, cold promotes the reanimation of the brain even when it is badly injured. But this requires further work.

Toward organism reanimation

What are the initial problems on which the science of organism reanimation must work? Methods of delaying the death process and preventing biological death must first be sought. Further research into methods of artificial cooling looks very promising in this respect. The creation of a medicinal mixture with the same action as cold, which would delay all vital processes and the disintegration of the vital organs and tissues, would be very useful. But this mixture must not interfere too deeply with the functions of the central and peripheral nervous system. Our first experiments present great prospects for surgery and medicine in general.

Don Champion, one of the band of Southwesterners who caught Alaskans napping, surveys a claim with a radar-like Tellurometer which can sight 40 miles from peak to peak.

The great Alaska ore snatch

EARLY last June, several small parties of men flew into out-of-the-way Alaskan towns like Homer and Kodiak in an area 200 miles southwest of Anchorage, down Cook Inlet near where it opens into the Gulf of Alaska.

One by one, the parties slipped behind the low Aleutian Range, which hugs the shore, and joined up 42-strong at the head of Kakhonak Lake.

Next morning, they were up at four, and from under a brush pile of camouflage they drew their red-painted claim stakes.

The men were a band of Oklahomans out to make an ore-snatch from under the noses of Alaskans.

On the second day, Alaskan noses began to sniff something. Gold, they thought. Rumors flew through Anchorage onto the front page of the newspaper. But when men flushed with gold fever tried to charter helicopters, they found that the mysterious group had chartered every one in Anchorage for ten days.

The most determined men took off the next day in fixed wing airplanes to trail the staking party's helicopters. The five helicopters scattered into the low clouds, feinted off into the wilderness, and even landed men to stake claims they had no intention of registering. A few outsiders slogged in on foot, but the helicopters flew rings around them in the rough country.

Whatever fever hadn't cooled by then fizzled out after word got around that the scramble wasn't for gold after all.

The prize was iron, a billion tons,

Adapted from *Horizon*, published by Pan American Petroleum Corp., Tulsa, Okla.

Pan Am Corp.

Helicopters easily outdistanced rival claims-staking crews who had to come in on foot. Rivals found that all the helicopters in Anchorage had been chartered for ten days.

the biggest deposit in the United States outside of Minnesota, and possibly the seventh or eighth largest ever discovered anywhere.

The Oklahomans were oilmen, naturally enough, from the Pan American Petroleum Corporation of Tulsa. Two years before, in the summer of 1962, Pan Am was tending to business prospecting for offshore oil when it stumbled across the iron.

The company had sent a twin-engine Aero Commander over the Cook Inlet Basin trailing a magnetometer in a boom sticking out of the tail. A magnetometer measures distortions in the earth's magnetic field, principally those caused by magnetite, a combination of iron oxides ($Fe_2O_3 \cdot FeO$). Over a long time the earth's magnetic field aligns the molecules in a mass of magnetite until it acts like a bar magnet lying parallel to the lines of force.

Basement rock contains a low concentration of magnetite. Over the basement lies the sedimentary rock where oil is found. A magnetometer chart indicates the depth of the magnetite and therefore the thickness and shape of the sedimentary rock.

Occasionally, during such a survey, the plane swings off course to check an area where the basement granite may break through to the surface with a high concentration of magnetite. Even if the amount of magnetite is too small for iron mining, it often indicates the presence of other minerals, particularly asbestos, sulfur, lead, nickel, copper, gold, titanium and chromium.

On one of these swings, the plane looped over the mountains west of Kamishak Bay. Later in the day, it landed in Homer on the Kenai Peninsula, from where the charts were relayed to the headquarters of Aero Service Corp. in Philadelphia for conversion to maps. Then all the data was sent to the Pan Am division office in Calgary, Alberta.

Supplies for the camp on Kakhonak Lake were airlifted in by helicopter or pontoon plane. When the surrounding territory was fogged in, the men fished for lake trout.

Duane Reno, geologist and magnetometer expert, studied the records. He was astounded to see that the chart needle had given a tremendous kick as the airplane had swung inland. According to Homer Jensen, who has directed over 3,000,000 miles of aeromagnetic surveying for Aero Services and who took part in the world's first survey in 1944, "In the past 20 years, man has virtually completed the huge task of exploring the earth's surface for evidence of mineral deposits. In all the world, only a few outcropping ore bodies can have gone undetected." This appeared to be one of those few. Somehow prospectors and magnetic surveyors, who have covered most of North America, must have missed this remote corner.

It was already November, but something this big couldn't wait. Two geologists soon dropped from a helicopter into waist-deep snow, near Cook Inlet. They pawed down through the snow and snatched up some rocks. Anxiously they held a magnet to the samples. It would stick to chunks of ore containing over 20 percent magnetite. On many it did.

Later tests showed an iron content ranging from 11 to 18 percent. Spectrographic analysis revealed the space-metal, titanium, here a troublesome impurity. The results were promising. Everyone buttoned up for two years.

In May, 1963, amid the melting snow, a party of four went back to criss-cross the area with another magnetometer. They uncovered 20 deposits along a 40-mile strip.

The big staking party that fol-

Brush camouflaged the 5500 stakes for the 497 claims so that airborne competitors couldn't estimate the size of the job. Alaskans guessed something was up in two days.

lowed in June, 1964, was out to snatch these up as fast as it could. For ten to 16 hours a day, the men evaluated the sites—narrowing them down to seven major deposits —surveyed them into 20-acre claims and drove a post in each corner, and in the middle of each end and a discovery post with a can holding a claim notice, in the center.

To combat the craggy terrain the surveyors had brought along a Tellurometer. With this radar-like instrument they could sight 40 miles with an error of less than a foot, thus measure from one mountain top to another in a single jump.

Sometimes they also had to pack a rifle to ward off the big Alaskan brown bears.

Each evening the men returned to their little tent city for a hearty meal prepared by a chef, two bull cooks and a baker. Supplies were dumped on the ocean beach by an LCM and lifted over the mountains by helicopter. An Otter airplane landed on the lake with fresh food.

In 50 straight days, the crew staked 497 claims.

They represent the first big find of iron ore on the U.S. Pacific Coast. Not far away, Pan Am has reserves of natural gas it could use as fuel to turn the ore into pellets of concentrate which could be shipped out from the bordering ice-free portion of Cook Inlet.

On the other hand, although there is lots of it, the ore is of lower grade than that used today, and the market and mills of the West Coast are still too small.

Nevertheless, Pan Am is sitting tight, hoping its mountains of iron may yet turn into gold.

Treating a baby before birth

by Robert Hermann

CONSIDER the unborn human, the fetus. There he lies, safe, snug and secure inside his mother's uterus, drawing nourishment through the placenta, drinking in the amniotic fluid that surrounds him, occasionally sucking his thumb, drowsing away the weeks until he will be ready to live in the outside world.

A pretty picture, but not always true. Some fetuses get sick. Some die before they are born. Until recently, doctors had assumed there was little they could do about this; their efforts at treatment had to wait until the baby was born. Occasionally they hastened the arrival of a sick baby by inducing labor or performing a Caesarian section. But it was hard to know just how sick the baby was. The risks of premature birth might be greater than the risk from the baby's illness.

Now a small group of doctors in several countries is challenging the medical profession to regard the unborn fetus as a patient, and to get to work on curing his ills. Their most daring feat thus far has been the administering of blood trans-

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fusions to the fetus in the uterus. This process, started little more than a year ago, already has saved the lives of dozens of infants whose blood was being destroyed by antibodies from their mothers.

For the future, these "fetologists" foresee treatment of fetal virus infections that may cause birth defects or death. They even foresee surgery preformed on fetuses *in utero* to remedy defects. By such means, they say, the United States' disturbing lack of progress in reducing infant mortality rates may be corrected.

At a meeting of the American Academy of Pediatrics in New York City recently, Dr. Jerold F. Lucey of the University of Vermont attacked the "myth" that it is "impossible to study the human fetus *in utero* without subjecting the fetus to prohibitive risks." It is time, he said, to knock down the "emotional barrier we have toward the research study of human life *in utero*."

In terms of medical care, the fetus has been a second-class citizen. The obstetrician is primarily concerned about the welfare of the mother, and the pediatrician can't see the baby until it is born. In the future, Dr. Lucey predicts, care of the fetus will rest with obstetrical-pediatric teams assisted by physiologists and electrical engi-

Mottke Weissman, Medical World News

The unborn baby is the patient as Dr. Vincent J. Freda of New York City performs an amniotic tap. Test helps determine if fetus is suffering from deadly Rh blood disease and what treatment is indicated.

neers. (The engineers will supply sophisticated new instrumentation for "seeing" the fetus.)

Research on the fetus is still in its infancy, but already the picture of undisturbed fetal bliss is changing. Small microphones taped to the mother's abdomen have shown that the fetal heart beat jumps when there is a loud noise, when the mother is speaking, or when someone is speaking to the mother. As every mother knows, the fetus does considerable squirming around. And new uses of X-ray photography have shown that fetuses do suck their thumbs. They also gulp down large amounts of the amniotic fluid that surrounds them, for reasons still unknown.

Many doctors remain skeptical about any tampering with the human fetus for research purposes. But Dr. A. W. Liley of New Zealand argues that increasing knowledge of the fetus increases our appreciation of the unborn infant as a human being in his own right, entitled to medical attention to his problems.

It was Dr. Liley who first transfused a human fetus successfully. The baby was born Sept. 20, 1963, in New Zealand, and a first-birthday picture of the healthy, handsome child now adorns Dr. Liley's desk at Columbia University in New York City, where he is on a one-year fellowship. Following Dr. Liley's lead, physicians are now administering fetal transfusions in Boston, Detroit, Rochester, N.Y., on the West Coast, in Winnipeg, Man., London, Ont., and in other places.

The transfusions are given to fetuses suffering from erythroblastosis. This is the well-known Rh blood disease, in which the mother's blood is Rh negative and the baby's blood is Rh positive. The mother's body, sensitized by the baby's blood, produces microscopic antibodies that attack the baby's red blood cells. The baby becomes anemic; the oxygen-carrying capacity of its blood is reduced. As the baby's blood is destroyed, its body becomes hydropic, swollen with fluids. If such a baby lives to birth, it is given several complete changes of blood to flush out the mother's antibodies.

Transfusions before birth

Dr. Liley's innovation is to give the needed transfusions before the baby is born. The alternative is to induce labor or perform a Caesarian section and get the baby out of its antibody-laden fetal environment before it dies. But this exposes the baby to the many risks of premature birth. Nevertheless, this policy has been pursued aggressively and successfully at Winnipeg General Hospital by Dr. John M. Bowman and his associates. He also uses some fetal transfusions.

To prepare for a fetal transfusion, Dr. Liley injects a radio-opaque dye into the amniotic-fluid cavity, which contains the baby. As the fetus drinks in the fluid, the dye becomes visible by X-ray in its

To give a fetus a transfusion, the doctor aims a long, hollow needle into the baby's abdomen, then feeds in red blood cells through a catheter.

intestine. Dr. Liley uses an electronic image intensifier to get a brighter X-ray image and reduce the radiation dose. The X-ray picture shows the position of the fetus.

The blood is to be injected into the baby's abdominal cavity; through the lining of this cavity, the peritoneum, the blood will be absorbed. Packed red cells are used instead of whole blood, since it is the baby's red cells that are being destroyed. The type is O negative, which the mother's antibodies will not attack.

The doctor's aim is crucial as he thrusts the long, hollow transfusion needle through the mother's abdomen and into the baby's peritoneal cavity. If the needle hits the baby's lung or liver, the thrust will be fatal. So, Dr. Liley advises, "Give the fetus time to make himself comfortable. In 20 minutes or so he will be lying on his side." Avoid last-minute poking or prodding, which the fetus doesn't like, he advises. The mother is kept drowsy under sedation, and is given a local anesthetic where the needle will enter.

Then, a quick check of the fetus' position on the X-ray, and a quick thrust of the needle to a predetermined depth. The fast, sure thrust is important, Dr. Liley explains, because "the baby is a human being, he doesn't like to be pricked, and if you go about this tentatively, he'll hop out of your way."

Baby's abdomen

Once the needle is in place, a thin, hollow tube, or catheter, is inserted through the needle into the baby's abdomen. The red blood cells, three to five ounces, are fed in slowly through the catheter. Enough blood must be used to transfuse not only the baby but also the placenta, to which the baby is attached by its umbilical cord. The placenta is the temporary organ in which foodstuffs and waste products are exchanged between the mother's blood and the baby's blood.

Thus far Dr. Liley and his associates have transfused 32 fetuses at the University of Auckland without losing a mother. Of the 32 fetuses, 14 were already so swollen that they could not have been expected to live, he said. Of the 18 others, there were 11 healthy survivors, and "we have 3 more going along well at the moment."

How do the doctors know a fetus is suffering from erythroblastosis? A new method of analyzing a sample of the amniotic fluid tells the story. As the baby's red cells break down, a pigment called bilirubin is released into the fluid. By measuring the darkness of the fluid at various wave lengths of light, doc-

Virus infections and metabolic disorders may be detected early and treated, thereby heading off mental retardation and cerebral palsy.

tors can tell how seriously ill the fetus is. By this means they can now decide with greater confidence whether to induce a premature birth, or to transfuse the fetus.

Fetuses can be given repeated transfusions if necessary. In a few cases their blood has been completely replaced before birth. Doctors at a Windsor, Ont., hospital were startled when some fetally transfused babies were born with Rh-negative blood. It appeared they had transfused the wrong babies, since the blood disorder arises only in babies with Rh-positive blood. To the doctors' great relief, the babies began manufacturing their own Rh-positive cells soon after birth.

Premature labor

Before Dr. Liley began his fetal transfusions, it was widely believed that sticking a needle into the uterus would send a mother into premature labor. Dr. Liley has not found this to be true. In at least one other hospital, however, it has been reported.

The transfusions usually are done at 33 or 34 weeks of pregnancy, after the fetus is fairly completely formed. (Up to three months of pregnancy, the infant is technically an embryo, not a fetus.)

Spectacular as the fetal transfusions are, Dr. Lucey of the University of Vermont foresees even more spectacular developments in diagnosis and treatment of the fetus. It may be possible, he speculates, to transplant bone marrow to a fetus, strengthening its blood-making capacity.

Early detection of disorders

Virus infections and metabolic disorders may be detected early and treated, heading off such disorders as mental retardation and cerebral palsy while the fetus is still developing rapidly.

New instruments and techniques for studying the fetus are on the way. Dr. Ian Donald in Scotland has used sonar equipment to make pictures of fetuses with sound waves. Dr. Stanley Birnbaum of Brooklyn, N. Y., has used heat waves for the same purpose. The technical barriers to research on the fetus are not as great, in Dr. Lucey's opinion, as the emotional barriers are to many people.

We can monitor the pulse, blood pressure, and temperature of astronauts in space, Dr. Lucey points out. So there is little excuse, he thinks, for "allowing patients—the fetus in this case—to die *in utero* from anemia when they are only inches away from a blood transfusion."

RCA President Elmer W. Engstrom displays new computers' tiny circuits.

How to pick a computer

Not all computers do the same job. Some are designed for complex work, some for routine data processing. A number of them have just been developed. Here are the principal kinds.

by Hubert Pryor

Not long ago, Radio Corporation of America introduced a new computer series—Spectra 70—which, it said, "combines technological advances beyond those of any other computer system."

The announcement climaxed a year of frenetic activity by computer manufacturers to introduce data-processing systems with features that surpass any that preceded them.

Two principal features mark this so-called "third generation" of computers:

1. Their new microelectronic circuits provide vastly greater speed, compactness, sophistication and dependability.

2. The "languages" in which they operate are compatible, so that they can be made to work with a manufacturer's earlier models and with the models of other manufacturers.

Businessmen and researchers can now build a computer complex by putting together just the components they need and they don't need a barn to house the equipment.

What are the systems that are now or soon will be available, and what do they do?

Here, based on information they provided, is what the major manufacturers have to offer:

BURROUGHS—*The B 5000*, a new solid-state electronic system for problem-solving and data-processing. It is "the first system to take

maximum advantage" of modular equipment design and the latest techniques for automatic programming, automatic operation and multiple processing. It is simpler and less costly, yet provides faster, more powerful, more versatile productive abilities than earlier models.

The B 5500, a highly advanced information-processing system that spans the medium, intermediate and large-scale ranges of computer equipment.

The E 2100, a direct accounting computer system designed for any business whose needs are beyond the capabilities of conventional accounting equipment but which can't justify the cost of large-scale electronic data-processing systems.

The B 200, a punched-card system with a flexibility that permits the use of other media-handling devices in configurations designed to meet individual requirements.

CONTROL DATA CORP.—*The 6000,* a series of super computers ordered by leading research organizations requiring high-speed computation. *The 6400* is said to execute instructions at the rate of 1 million a second; *the 6800,* at a speed of 12 million a second.

GENERAL ELECTRIC — *The Compatibles/600,* a new, advanced, high-performance, large-scale computer for use in business, scientific and real-time applications. A new software package eliminates programming complexities and is "the most potent, most inclusive, most thorough" executive routine in the industry, making multiprogramming and multiprocessing "practical for the first time."

The Compatibles/400, a series with "problem-solving powers that no other data processor in this price class can approach." It combines hardware, software and an operating system into a fully integrated package. All computers in the series use a 4-character word with 24 bits plus parity; use one- or two-address instructions; accept alphanumeric data and do decimal arithmetic. Special input/output channels provide access to a communication network or remote stations. All systems in the series have batch, random and real-time capability.

HONEYWELL—*The H-1800,* a very large-scale processor with 32,768 words of memory capable of executing 90,000 three-address instructions per second. It can also run several programs simultaneously and independently in its memory.

The H-800, a large-scale computer having three-micro-second access time to any of 8,192 48-bit words of memory (each containing eight alphabetic characters or 12 numeric characters).

The H-1400, an intermediate system.

The H-400, a medium-scale system.

The H-200, a small, low-cost business computer with speed and performance characteristics comparable to much larger systems. Its

modules can be combined to contain 2,048 to 32,768 characters of memory.

The H-300, a scientific computer in the same family as the *H-200.* It has a "family interface" unit that permits it to be directly connected to its own or any of 30 different input/output devices of the H-200.

IBM—*The IBM System/360,* a new, "third-generation" series of computers using microelectronic circuitry and offering "bulk core storage" that permits a memory capacity of up to 8 million characters, each available in 8 millionths of a second. The speed and capacity can be arranged in 20 different combinations to suit the user's needs, from a small sorting system to a sophisticated computing configuration. All are compatible in their programming.

IBM System/360 includes Model 30 to direct computer system's basic tasks.

To date, the computers made by IBM, the world's largest manufacturer of data-processing equipment, have ranged from the powerful *IBM 7090/7094* series to the small desk-size *IBM 1620.*

NATIONAL CASH REGISTER —*The NCR 315,* a medium-size system, now available with RMC (Rod Memory Computer), that can process about 100,000 instructions per second and control a wide variety of input/output equipment as the user's needs change. The memory is made up of cylindrical thin-film, rod-like magnetic storage devices and has a basic cycle time of 800 billionths of a second. Storage ranges from 60,000 to 240,000 digits (4 data-bits each). The system is basically business-oriented, but it also has features that make it a balanced scientific and engineering data processor as well.

The NCR 395, a desk-size business system which uses computer addresses and instructions, with a magnetic disc memory of 120 14-digit words, accessible at the rate of 29 times a second.

The NCR 310, a series for retailing and financial applications.

The NCR 304, the largest of NCR's systems.

RCA—*The Spectra 70,* a new series comprising four compatible general-purpose computers and more than 40 interchangeable peripheral devices. Innovations in the two larger computers include fully integrated circuits—"the world's fastest

and the most reliable commercially available." The series can also "speak" all of the most common programming, data and communications languages.

The RCA 3301, an advanced, medium-priced, user-oriented system with emphasis on enhanced performance, greater reliability and adaptability to both real-time and non-real-time environments.

The RCA 601, the largest of RCA's product-line computers, with many powerful programming and operating features. It has a basic high-speed memory capacity of 8,192 words of 56 bits each which can be expanded by adding up to 12 memory stacks of 2,048 words each.

The RCA 301, a series offering flexibility at low cost, available with a high-speed arithmetic unit to add scientific capability.

The RCA 4100, a series of military digital computers designed for real-time control and scientific data-processing requiring simultaneous execution of a number of different programs.

UNIVAC—*The Univac 1004,* a low-cost, externally programmed card processor that reads, processes

What those words mean

address A symbol designation of where data are stored.
alphanumeric Denoting a system including letters and digits.
bit A basic symbol in the binary system (for example, 0 or 1).
bit, parity A check bit that indicates whether the total number of binary "1" digits in a character or word is odd or even.
character One of a set of elementary marks that may be combined to express information (for example, 0 to 9, A to Z).
compatible Able to accept and process another computer's data.
computer A machine for carrying out calculations and performing specified transformations of data.
data processor A machine or system that sorts or otherwise manipulates large quantities of information without extensive calculation.
decimal Using the digits 0 to 9.
digital computer A computer handling precise quantities, as opposed to an analog computer, in which numbers represent physical magnitudes, such as flow, temperature. The first counts, the second measures.
hardware The mechanical, magnetic, electrical or electronic devices or components of a computer.
input The information fed into a computer, in the form of numbers or letters, from punched tapes, magnetic tapes, punched cards, etc.
interface A common boundary between systems or parts of a single system.

and prints at computer-like speeds. The 1004-III is equipped with magnetic tape.

The Univac 418, a real-time, stored-program computer with full communications capability, which allows the user to mix real-time and batch processing to meet his particular needs.

The Univac 490, a large-scale, real-time computer used for information retrieval, airlines reservations, inventory control, message switching and other applications that require information availability with virtually no time loss.

The Univac 1107, a thin-film memory system. It and its successor, *the 1108,* are large-scale, general-purpose computers with core memory cycle time of 1.5 millionths of a second and 750 billionths of a second, respectively.

The Univac 1050, a family of six systems with a wide variety of configurations for small and medium-scale users.

This is the fourth and final article in a series on computers. Future issues will carry periodic reports on computer news as it occurs.

language A system for representing and communicating information between people and machines.
memory The component in which information is stored, subject to recall.
module A block of equipment that can be added to increase the capacity of a computer system.
operating system An integrated collection of service routines for supervising the sequencing of programs by a computer.
output The results of computer operations in the form of punched cards, punched or magnetic tapes, or printing.
peripheral Referring to auxiliary equipment that can be placed under the control of the central computer.
program A plan for the computer solution of a problem, including the complete sequence of machine instructions and routines.
random processing The processing of data that is in no pre-determined order when it enters the computer.
read To acquire information, usually from some form of storage.
real time processing Processing data fast enough so that the results can monitor or control the process itself.
software The programs and routines used to extend a computer's capabilities, such as compilers, assemblers, etc.
solid-state device An electronic component that conveys or controls electrons within solid materials, as opposed to a vacuum or gas. Examples: transistor, germanium diode.
word An ordered set of characters which occupies one storage location and is treated by the computer circuits as a unit.
write To transfer information to an output medium.

The undersea history of America

by Malcolm C. McKenna

THE IDEA that the sea once covered the land is an old one. We first become aware of the idea in the writings of such men as Zenophanes of Colophon (?576-480 B.C.) and Herodotus (484-425 B.C.). In the time of Zenophanes, rocks from Malta were used as ship ballast, and fossil shark teeth — known then as "Fossil Tongues"— were found in these rocks. To account for the remains of marine animals on the dry land of Malta, and for seashells found on the mountain heights elsewhere, Zenophanes reasoned that the sea must have invaded the land long before and later retreated. Herodotus applied the same reasoning to Egypt.

Readers of Plato are familiar with his treatment of catastrophic submergence of land in the "Timaeus," where the supposed sunken continent of Atlantis is discussed.

Biblical and other ancient literature of the Middle East is dominated by a tradition of universal deluge. Characteristic of this view is an extremely short time scale for the duration of our planet—measured in thousands rather than in billions of years. One flood during this period sufficed to explain all evidence of former seas on land. During the seventeenth and early eighteenth centuries, the argument even degenerated to a question of whether The Flood occurred in the spring of the year or in the autumn.

Little by little, the excrescenses of the Middle Ages were shaken off by the developing science of geology. As authoritarianism gave way

Colored area is approximation of North American continent about 500,000,000 years ago. Planet earth was 4,000,000,000 years old. Rocks had formed in the crust.

Approximation of the North American continent half way between the Ordovician Period and today, 270,000,000 years ago. Note growth of land inside volcanic arc.

to disciplined observation and description, ideas dormant for two millennia once more flourished while myths of The Flood retreated. By the end of the nineteenth century, only religious fundamentalists, occupied in what H. L. Mencken used to call "furious logic chopping," refused to accept the overwhelming evidence that not once but many times the seas have crossed where land lies now.

Because of a geological process that began a dozen or so million years ago, when the waters of the Colorado River system started to cut through its bed of rock in the southwestern United States, visitors to Arizona's Grand Canyon and to the Black Canyon of the Gunnison in Colorado can read in the exposed stone walls the record of repeated ebbings and flowings of the sea. The stumps of ancient mountains, faulted and folded, can be seen, and above them successive layers of sediment deposited under or on the margin of the water.

Where there are limestones, sea creatures once lived and died in quiet seas. Where there are red sands and clays, the sea had moved far away. Where the limestones reappear, the sea had returned far enough and long enough to deposit the fossils of aquatic life again.

On the plains of Kansas, the same quarter-inch thickness of limestone can be traced for hundreds of miles without a break. Here is a clear sign that these flat lands once were covered by relatively shallow and undisturbed water: a sort of inland sea, connected with but not truly belonging to the deep ocean.

Just how far back the history of this western American waterway goes can only be guessed. Scientific estimates place the age of planet earth at about 4,500,000,000 years. The oldest rocks in the earth's crust have been radioisotopically dated at about 3,000,000,000 years. Some of these very old rocks are along the

The North American continent only yesterday, about 100,000,000 years ago, in the age of mosasaurs. This Cretaceous (chalk) period got its name from the Cliffs of Dover.

In Eocene (dawn of mammals) time, about 45,000,000 years ago, the North American continent neared its present shape. Upheavals drained the great midwestern sea.

During the Cretaceous period 100,000,000 years ago, giant sea lizards hunted in the water over Kansas while pterodactyls glided above.

Great Lakes, some almost as old are along the Pacific coast.

Drifting continents

One of the liveliest arguments in science today has to do with the possibility of drifting continents. A currently popular theory holds that there once was only one continent, which split into parts, which went separate ways. If a single mother of all present continents did exist, where on the globe was it centered? Without knowing the answer to that question, we cannot suggest the northern-most limit of the original outline of what is now North America. For North America in the beginning may have been nothing more than a peninsula, as India is today. But whatever form the original American land mass had, we know it reached southward over the Great Plains; the sedimentary sequence tells us that early land extended close to the present-day shores of the Mexican Gulf.

There were tremendous upheavals within the earth, caused perhaps by convection cells moved by the opposing forces of heat and gravity. As these occurred, the ancient land mass rose and fell and rose again. The first clear picture we have of a separate American continent is in Ordovician time, a period named for a tribe that occupied a region in Wales where rocks characteristic of that period were first identified. This was 500,000,000 years ago, and a rough map of Ordovician North American (see page 80) is the first of a series of four maps showing the continental changes.

100,000,000 years

About 100,000,000 years earlier, the land had extended southwestward as far as Arizona. Since then, however, the sea had moved northeastward toward that part of Canada centered around Hudson Bay. Most of the United States was under water, and marine muds containing relics of ancient sea life such as trilobites and graptolites were deposited by a shallow sea that connected the Arctic and Atlantic oceans on the west. Along what are now the Atlantic and Pacific coasts of the United States, volcanoes were rising from the ocean floors and creating arcs of islands.

After that, the sea slowly retreated again until Pennsylvanian Time, named for the location of coal beds laid down at that period: 270,000,000 years ago. Vast areas in Colorado and nearby states were uplifted into archipelagoes of large islands (see map, page 80). Within

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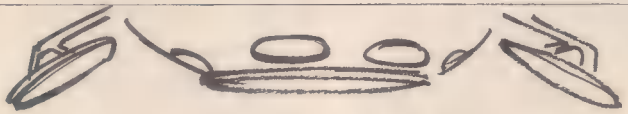
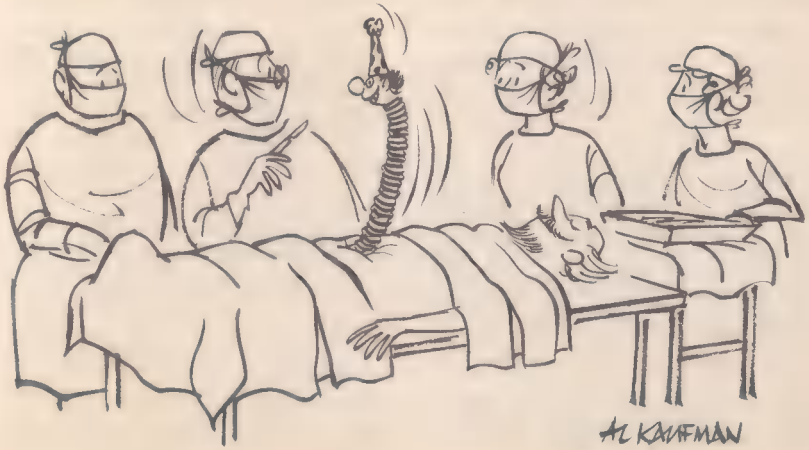
the arc where volcanoes had been thrown up earlier to the east, a long peninsula now emerged, thrusting the Appalachian Mountains above the sea. On the westward side of this peninsula, swamps formed, and these in time became compressed into huge veins of coal.

Gradually, the withdrawal of the sea continued until about 180,000,000 years ago. But then the water returned and the land area again shrunk until, about 100,000,000 years ago, in the Cretaceous (chalk) period, the extent of marine deposition was nearly as great as it had been in Ordovician days. This "time of chalk" got its name from the cliffs carved at Dover and elsewhere along the English Channel in limey sediments made from the shells of tiny sea animals. The chalky remains of similar creatures were deposited in western Kansas, where giant sea lizards called mosasaurs hunted in the waters of the midwestern sea while pterodactyls glided overhead. Meanwhile (see page 81) the Appalachian Mountains in the east and another and higher chain of mountains from Alaska to Mexico were being eroded by the sun, wind and rain. Debris from them was washing down in the rivers to fill the inland sea.

Finally, as the land rose and the Rocky Mountains began to form at the end of the Cretaceous period (see map, page 81), the inland sea broke in two in Alberta. The northern half of the sea retreated to the present shore of the Arctic Ocean, the southern half to the present shore of the Gulf Coast.





SCIENCE ABC's

Sound: Waves that travel in the air

Researcher sets equipment for generating sound at 10,000,000,000 cycles/second.

SOUND is caused by the rapid vibration of the air. A vibration is a shaking to-and-fro, and if you have ever "twanged" a stretched elastic band or the string of a guitar, you will understand one way in which the air can be made to shake so as to produce a sound. When you strike the note known as "middle C" on a piano, a hammer hits the piano wire and causes it to vibrate about 256 times per second. As it moves backwards and forwards it gives the air in contact with it a sharp push. This air pushes the air in front of it and then bounces back. Meanwhile, the pushed mass of air pushes the air in front of it and bounces back, and so the "push" is passed on from one mass of air to another right across the room.

You can see the same sort of thing happening when a locomotive bumps a train of railroad cars. The engine hits the first car, which bounces off the second and causes the second to bounce off the third, and so on. You can sometimes see the bounces travel right along the train, from engine to caboose, although the train itself does not move. This sort of motion is called "compressions-wave" motion; sound waves are of the same kind. Thus, though the sound travels across the room, the air itself does not—it merely shakes to-and-fro. (If it did move, you would feel a strong wind blowing every time anybody spoke.)

But the air-shakes or bounces travel very rapidly — about 720 miles per hour. In the case of middle C, each shake travels about 4 feet before the next one starts, so we say that the wave length of middle C is 4 feet. Higher notes have a shorter wave length, because they vibrate more rapidly, but lower notes have a longer wave length and vibrate more slowly. The human ear cannot hear waves shorter than about ½ inch, which come at some 20,000 per second, or longer than about 50 feet, which come

at 20 per second. These limits represent the high squeak of a bat and the lowest bass note of a great organ —a note so low that you can actually feel the air throbbing as you listen.

But no matter what the wave length of the sound, it always travels at the same speed in air. Sound can also travel through liquids and solids, but in these mediums its speed is much greater. In sea water, for example, it is 3,350 miles per hour, so that this is the rate at which the sound of a submarine's engine travels to the listening microphones on the bottom of an enemy destroyer.

Sound travels faster still through metals, its speed in steel being about 11,000 miles per hour. Sound cannot travel in a vacuum.

The speed of sound in air enables you to tell how far away a thunderstorm is. You see the light of a lightning-flash almost at the instant at which it occurs, but the sound of the flash—which is the thunder—follows more slowly afterwards. Sound takes about 5 seconds to travel a mile, so that if you start counting seconds the moment you see the lightning, and go on until you hear the next clap of thunder, you have only to divide the result by 5 to tell how many miles away the flash was.

Music vs. noise

The difference between musical sounds and "noise" is simply that the vibrations in music are perfectly regular and are of only a few controlled wave lengths. But when you drop a book on the floor, it disturbs the air in a very irregular and violent fashion, and sound waves of several mixed lengths come out, colliding with one another in every imaginable way. Your ear is unable to sort them out and so you hear a noise instead of a musical note.

Spectrum: All colors of the rainbow

Sir Isaac Newton (1642-1727), who was a very practical scientist, made many experiments with sunlight. One of these experiments was carried out (about 1665) in a darkened room in which he arranged for a beam of sunlight to stream through a small round hole in a window shade. He placed a glass prism in the path of this beam and, instead of observing a picture of the hole, he saw a wide band of rich colors, red at the bottom, and violet at the top.

He called this the "spectrum," and in this way he discovered that white light was made up of many colors. He noticed that the prism had the effect of separating these colors, by bending or refracting

them twice at two faces of the prism, and that some colors were refracted more than others. Violet light, he noticed, was refracted most, and red light the least. When he placed a second prism in the same way but behind the first, the band of colors became wider. There were no new colors. The second prism was then turned around so as to bend or refract the color rays in the opposite way. He found that the colors came together again to form white light. These important discoveries are now among the chief facts in our knowledge of light and color.

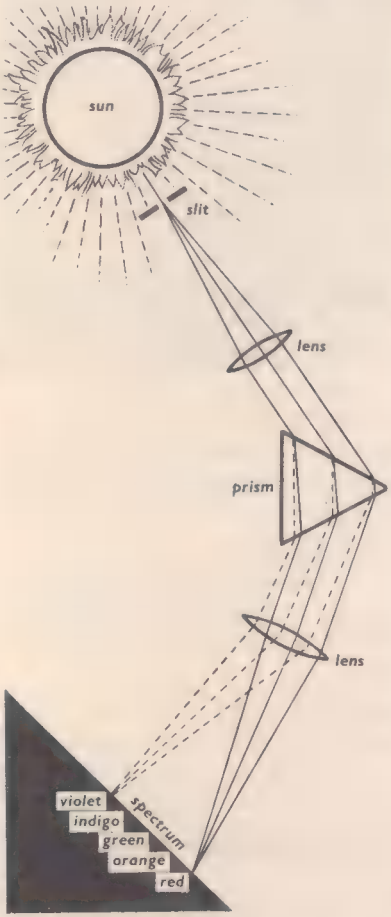
Newton found that his spectrum was not pure, for some of the colors overlapped one another. After some thought he realized that the hole was too wide, and that a thin slit was needed. The hole was like a number of thin strips, and each produced its own spectrum. After these discoveries many experiments were made and it was found that a much better spectrum was obtained by using a very thin slit together with a lens. Today we know that white light is a mixture of light with many different wave lengths, and that each band of color is an image of the slit formed by the particular wave length of the color.

The spectrum has enabled science to study materials very carefully, and this can be done by an instrument called a spectrometer. Light passes through a slit into a tube called a collimator. This consists of lenses which collect the light. After passing through the collimator, the light then passes into a prism. The spectrum so formed is viewed through another tube, called the eyepiece, in which are lenses that make it possible to see a very clear spectrum. Now, when table salt is put into a Bunsen burner a bright yellow flame is formed. When this light is put in front of the spectrometer slit, its spectrum viewed through the eyepiece, consists of a narrow yellow line on a dark background. This line is a single image of the slit and is formed by light of one wave length. It is the spectrum line of sodium contained in the salt.

Each chemical element can be heated like sodium, and each has its own special spectral lines, for some, unlike sodium, have more

Technician examines spectra of the outer atmosphere of the sun obtained by a solar eclipse expedition of Cambridge Univ. Cambridge Observatories specialize in stellar photometry.

Above: Spectrum lines of various materials. Below: Diagram of the workings of a spectrometer. Light passes through a slit, is collected by a lens, then passes through a prism. The spectrum that is formed by the prism is made clearer by another lens.



than one. When we wish to examine a material, we make it very hot, and examine the light from it. A study of the lines in the spectrum

Spectrometer (or spectroscope) showing prism in center. Light enters through one tube, passes through the prism and is viewed through the eyepiece tube.

of this light enables us to find what elements are contained in the material.

The sun itself gives out light, because it is a very hot gas, and the existence of dark lines in its spectrum shows that elements such as hydrogen, oxygen, etc., are present in its envelope. These elements in the cooler outer envelope rob the sun of some of the white light from its very hot interior, and so what we see in the sun's spectrum are dark lines which show the wave length of the absent light. When they are studied they are recognized as having the wave lengths of elements known on earth. In this way it has been possible to find out what is in the sun's outer envelope. The dark lines which show up in its spectrum are named after Joseph Fraunhofer, who studied them. Other heavenly bodies are also studied in this manner.

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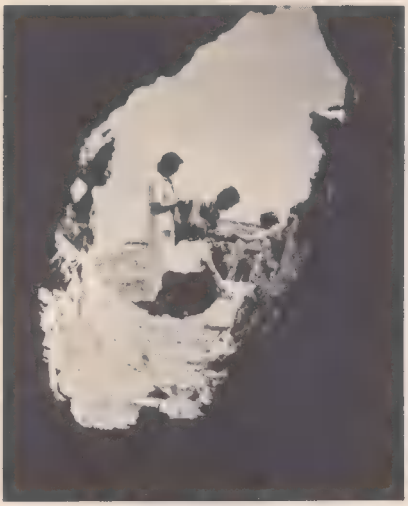
SCIENCE DIGEST MAGAZINE ——— THE SCIENCE NEWS MONTHLY

If you are a science teacher in high school or college, write to John Mitchell, 250 West 55th Street, New York, N.Y. 10019, for special School Plan rates & information.

Quiz—How we use rocks and minerals



by John and Molly Daugherty

What do you know about the world's present uses of rocks and minerals?

1. Man has used several varieties of cement for hundreds of years. Which had the earliest known use?
   a. Natural cement from certain types of limestone.
   b. Portland cement.
   c. Pozzolan cement.

2. Which one of these building materials would insulate your house the best?
   a. Structural concrete containing pumice.
   b. Common brick.
   c. Concrete with gravel, sand and cement.

3. Sixty percent of the production of one of these rocks in the United States is used in agriculture. Which one is it?
   a. Gypsum rock (or mineral).
   b. Phosphate rock.
   c. Limestone rock.

4. The mineral kaolin found in certain clays has its major use (over half of the production) in:
   a. Structural clay products.
   b. Oil-well drilling muds.
   c. Fillers and coatings for paper.

5. Which one of these rocks has found some use as a sharpening stone?
   a. Quartzite.
   b. Soapstone.
   c. Granite.

6. Which one of these iron ores, all oxides of iron, is the richest source of iron?
   a. Limonite.
   b. Magnetite.
   c. Hematite.

7. These minerals occur in massive granular form or as cubic crystals. Which one is salt?
   a. Galena.
   b. Halite.
   c. Pyrite.

8. Which one of these minerals of gemstone quality has been used in depth-sounding apparatus for submarines?
   a. Opal.
   b. Aquamarine.
   c. Tourmaline.

9. From which of these rocks can rock wool (mineral wool) be made?
   a. Granite.
   b. Slate.
   c. Marble.

10. About 90 percent of the earth's crust is composed of four mineral groups. Which of the following is the most abundant?
    a. Mica.
    b. Quartz.
    c. Feldspars.

Answers:

1—c Pozzolan cement. During early Roman times, volcanic ash and lime were finely ground and mixed to make cement. The ash was found near Pozzuoli close to Naples in Italy.

Natural cement was made in England about 250 years ago, using limestone with a content of clay and silica. This was heated and ground to produce cement. Portland cement also was developed in England about 50 years before it was produced in the U. S. in 1875 in the Lehigh Valley of Pennsylvania.

2—a Concrete containing pumice as an aggregate instead of sand and gravel. The conductivity of heat through equal thicknesses is only one-sixth as great in pumice concrete as in regular concrete. Pumice concrete is light-weight and more resistant to shock, and fire damage.

Common brick has a lower heat conductivity also—about two-fifths as great as that of ordinary concrete.

3—b Phosphate rock (phosphorite). All plant and animal life needs phosphorus in suitable chemical form. The U. S. produces nearly 90 percent of the world's output of sedimentary phosphate rock, and about 60 percent of this ends up in agricultural use as a fertilizer. Some is merely ground and put on the soil, but most is made into superphosphate by treating the rock with sulfuric acid. A smaller amount is made into a concentrated triple-superphosphate. The largest reserves are found in some western states, but most of the production comes from Florida and Tennessee.

Pulverized gypsum has some uses as a soil conditioner, too, for growing peanuts, etc. Limestone helps to correct acidity in soils.

4—c In filler and coating for high quality paper. Kaolin is a white, almost pure clay, which may consist of fine-grained residual deposits or sedimentary kaolin. Both are used in many products such as high grade porcelain, a filler in rubber, window shades and tooth powder.

Structural clay products are manufactured from a variety of clays and shales. These products include brick, drain tile, and sewer pipes. A variety of clay known as bentonite is used in preparing oil-well drilling muds, which absorb vast quantities of water.

5—a Quartzite. Quartzite is metamorphic sandstone, but it is much harder than sandstone and very fine-grained. The special forms of quartzite used have been generally protoquartzite or orthoquartzite.

Soapstone is a name given a massive talc or talcose rock. It is quite soft and has uses for sinks, table tops and electrical panels. Granite is a durable rock used in monuments, buildings and bridge piers.

6—b Magnetite. Magnetite ores of high purity may contain 70 percent iron. This ore is black and has magnetic properties.

Hematite, more abundant, is mined in larger quantities in the U. S. The iron content, however, is lower, usually ranging from 40 to 60 percent. Its color, usually reddish, may vary. Much of it comes from the Lake Superior region. Limonite is a

yellowish-brown hydrated oxide of iron. The percentage of iron in limonite is lower than that of the other two ores.

7—b Halite. Over 90 percent of our salt production comes from rock salt deposits. By 1958 our production reached 24,000,000 tons. Salt is one of the big four minerals used in vast quantities by the chemical industry. The others are coal, limestone and sulfur. Salt is a metallic ore, too, from which sodium metal is obtained. Michigan, Texas, New York, Louisiana, and Ohio lead in salt production.

Galena is a lead ore, and pyrite is a compound of iron and sulfur known of "fool's gold."

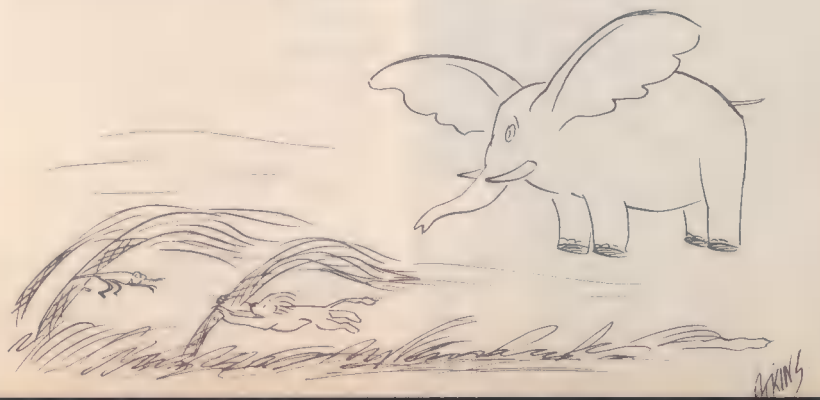
8—c Tourmaline. Several varieties of this gem are sensitive to pressure changes as well as temperature changes. The pressure changes induce charges of piezoelectricity in the stone. This property of tourmaline has been the one used in depth-sounding equipment for submarines.

9—b Slate. Waste slate left over from quarrying operations is fused with the slag from limestone in iron and steel mill operations. The fused material is injected into a jet of air or steam, forming rock wool. Rock wool is an excellent insulating material. Waste slate is also used in preparation of a light-weight aggregate for concrete. The waste is crushed and expanded under temperatures of about 1200° C. Rock wool may also be made from the slag of certain types of limestone in the same manner as with the fused slate and limestone slag.

10—c Feldspars. Feldspar is so abundant in rocks that it makes up about 60 percent of the earth's crust. Orthoclase and plagioclase are important feldspars. The colors of feldspar include pink, grey, and white. It is the most abundant mineral in igneous rocks. Feldspar has uses in ceramics and glass making.

Score Yourself.

9—10 right—Your knowledge of rocks and minerals isn't buried.
4— 8 right—Dig deeper next time.
0— 3 right—Your score is pretty rocky!



The Hugh Downs Column

60 quadrillion is a crowd

PEOPLE not yet middle-aged have seen the population of the world jump 50 percent in their lifetime. The rate of increase now amounts to doubling every 37 years. If this rate were to continue through the next 1,665 years without interference from such factors as heat limit, birth control, disease, famine, nuclear holocaust or interplanetary travel, there would be a mass of humanity equal to the weight of the entire earth.

Obviously this will not happen even if technology becomes sophisticated enough to synthesize organic compounds and reconstitute elements from nuclear particles on a wide scale. A heat limit would be reached long before Earth's entire mass could be converted to living tissue.

According to Dr. J. H. Fremlin of the University of Birmingham,

Even today, the author finds "standing room only" at a TV show. (Ray Borea photo)

England, the earth's population could rise from the present 3 billion to 48 billion using existing crops and agricultural methods. With these methods, eliminating all land wildlife and roofing over cities and roads with sufficient soil layers for agricultural purposes, plus efficient harvesting of sea food, 400 billion souls could live on the planet, or about 130 times the present population. This incredible congestion could be accomplished in a mere 260 years. In fact, unless some force intervenes—most likely a force subject to human decision—this state of affairs is inevitable.

160 square meters/person

By the year 2335, Dr. Fremlin writes in *New Scientist*, the population could rise to 3 trillion, or 1,000 times its present level, assuming technology could rise to the tasks of replacing ocean wildlife with edible cultured organisms and creating housing space over land and sea alike. (Each human would have a little over 160 square meters for his maintenance. That's about the size of a large living room.)

By utilizing sources of power other than natural sunlight for photosynthesis (for example, fusion of deuterium or systems of large solar mirrors in orbit), a world population of 15 trillion is conceivable. This figure represents 5,000 people for every one person now living on earth. The assumption that technology could keep pace with these steep requirements is not out of bounds, considering its own accelerating rates of growth in power and technique. The social adjustments present somewhat more of a problem. And most important, seemingly absolute limitations now loom, such as the finite quantity of matter represented by the earth and the heat problem.

1 quadrillion people

In 680 years' time, 1 quadrillion people will be breathing down each others' necks. The accomplishments of science will be impressive at this stage: direct synthesis of essential bulk foods; recycling of biological material (waste products in principle could be changed back into food by the addition of a small amount of energy, and cadavers could be homogenized and reabsorbed into the race); a mining operation of incredible magnitude and probing to undreamed-of depths; a staggering housing system encircling the earth with scores of levels of honeycombed quarters for the teeming units of humanity. Each individual, according to this population density, would have ½ square meter of the earth's surface.

A little over three more doublings of this population would bring on insurmountable refrigeration difficulties, Dr. Fremlin warns, unless the science of the day was able to roof in the whole planet, hermetically sealing oceans and all, and transfering heat by heat pumps to the outer skin.

"An outer skin temperature of

The vast universe already may contain many civilizations packed in a labyrinth of unending 1,000-story housing encrusting other planets.

300°C would give a heat extraction of 3 kilowatts per square meter and 1,000°C would give an extraction ten times greater. If heat removal were the sole limitation, then we could manage about 120 persons per square meter . . . which represents . . . a world population of 60,000 trillion in 890 years' time.

Heat limitation

1,000°C may be a rather modest figure for the technology of AD 2854 and the population could, as far as heat is concerned, be able to double again for each rise of absolute skin temperature of 26 percent. The difficulties in raising it much further while keeping all thermodynamic efficiencies high would, however, seem to be formidable. A rise to 2,000°C would give us less than 3 further doublings.

"We seem, therefore, to have found one possible absolute limit to human population, due to the heat problem, which at the present rate would be reached 800 to 1,000 years from now with a world population of 10^{16} - 10^{18}."

As unthinkable as some of these conditions may seem, dwelling on such alternatives as disease or famine or mass killing strikes me as not only more gloomy but somehow sterile. We aren't likely to level off in scientific advance or population increase. Perhaps interplanetary travel will relieve some pressure (it can scarcely be seen as a total solution); perhaps under pressure the human race will form a membrane around the earth and become a single, super-conscious organism, capable of stupendous technical feats such as harnessing the total energy of a planet or a star.

If living tissue were insulated against temperature extremes just under the skin of a body like the earth or the size of the sun and the technology of the civilization were sufficiently advanced to effect heat extraction by radiation from the skin at 5,000°C (comparable to the surface of the sun), might not such a star show a spectrum puzzling to astronomers who had analyzed spectroscopically only "natural" stars? And have there not been found recently distant bodies (quasars) whose radiation output is puzzling and unusual?

In this vast universe there may now be many civilizations packed in a labyrinth of unending 1,000-story housing encrusting planets similar to the earth. And in the vast reaches of the future we as the human race may ourselves one day form a tight-knit membrane around the earth with umbilical connections, synthetic nutrition and atrophied muscles, but with the power of galaxies at our fingertips.

Questions and answers

In your "Hot and cold quiz" (Jan. '65), two of the questions and answers are improperly formulated. None of the three answer choices to question five were valid; all of the three answer choices to question eight were valid. Eight out of ten valid questions and answers is a lousy score.

ROBERT SAXTON
Santa Paula, Calif.

The author replies

There is nothing wrong with the answers to questions five and eight.

Consider number five: *Vacuum bottles keep cold drinks cold for about 24 hours, but hot ones hot for only about 12 hours. Why? a. The vacuum prevents conduction of heat; b. No air between the walls prevents convection; c. The shiny surface of the inner container reduces radiation. Answer: c.*

The explanation points out that some radiation always takes place and when you fill the bottle with hot coffee (212°F.), the contrast between the temperature and 70°F. outside is great. When you fill the bottle with iced tea (32°F.), the contrast is not so great. The greater the contrast, the more heat lost by radiation.

The only thing I could have added to the explanation might have been that the vacuum is never perfect and eventually some conduction occurs especially through the cork or stopper. Convection of heat by the circulation of air in the vacuum space is negligible. But radiation is not prevented by a vacuum. The shiny surface reduces it by reflection.

Now, as to number 8: *Which one of these may be called a cooling process? a. The melting of ice; b. The boiling of water; c. The condensing of water vapor. Answer: b.*

Mr. Saxton claims all three responses are cooling processes. This is contrary to all heat theory. For instance, heat is required to melt ice—to change its state from solid to liquid without any change in temperature of the ice while this occurs. Naturally ice cools a Coke because it takes heat energy from the Coke to melt the ice.

Also when you come out of the water after a swim, you feel cool because the water starts to evaporate—this change in state from liquid to vapor takes heat from your body, and when water vapor condenses into rain, that same heat is released to the atmosphere. Boiling is just a special case of rapid evaporation (steam) and when it condenses back to water as it does inside a steam radiator, it gives up the heat, originally added, to the cast iron radiator. (The explanation stated, "It takes a lot of heat, about 540 calories, to turn one gram (1/45th of a pound) of water into steam. The heat to do this must come from the pan of boiling water, thus cooling it. Continued application of heat energy is needed to keep the temperature up to the boiling point.")

JOHN DAUGHERTY
Evanston, Ill.

Response to article

In your August, 1963, issue you published a one-half page article based upon an address I delivered in New York City at a meeting of the American Society of Abdominal Surgeons. Many patients have come to my office, from Canada and all parts of the United States, after learning about this treatment from your article.

In the article you mentioned only one part of the treatment—that was for headaches. If you would stress the importance of ligamentous relaxation as a cause of pain most anywhere in the body, you would be doing people a great favor. They would contact some doctor who is skilled in doing this type of work, which we call Prolotherapy.

WAYNE BRONAUGH, M.D.
Belpre, Ohio

Authoritative, lucid, incisive

I appreciate your thoughtfulness in sending me a copy of Mr. Stacy V. Jones' recent article on "The Invention Lag" (Jan. '65).

As usual, Mr. Jones is authoritative, lucid and incisive.

DANIEL V. DE SIMONE, Director
Office of Invention & Innovation
U.S. Dept. of Commerce
Washington, D.C.

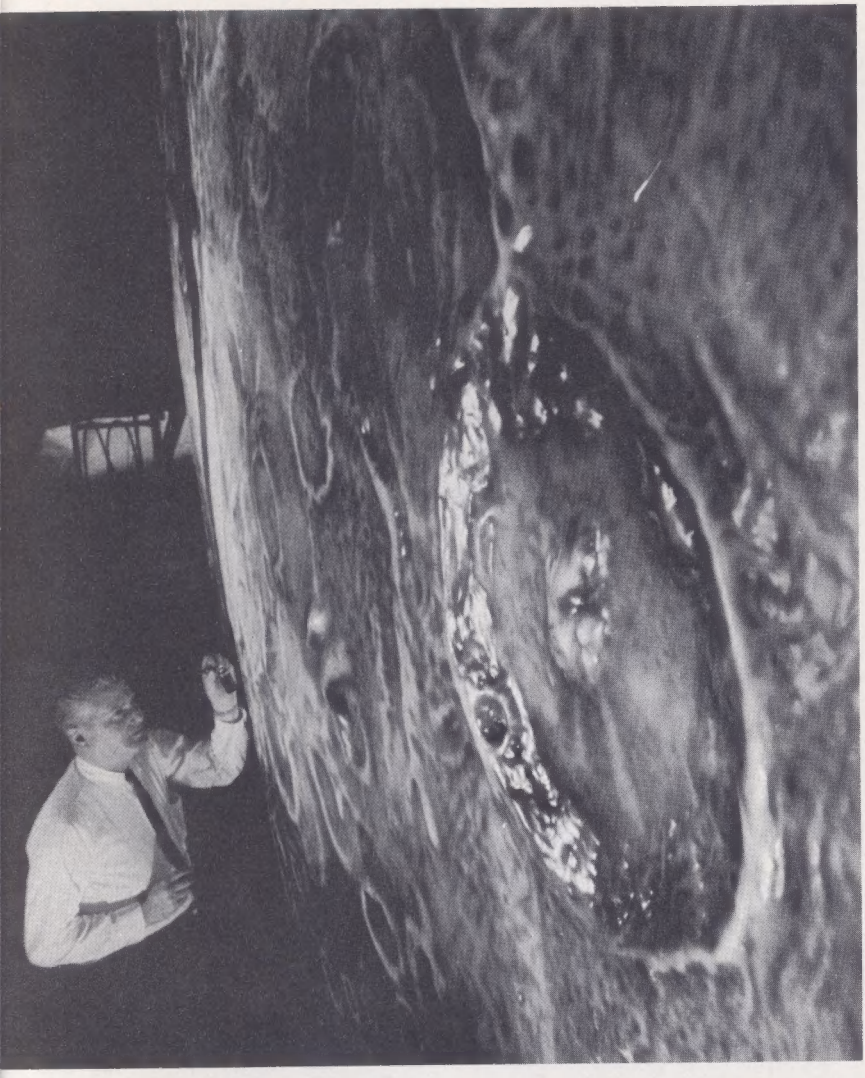
Up-to-date

I would like to commend you on the excellent job you do on your up-to-date scientific findings. *Science Digest* is a very interesting and informative magazine.

ROBERT SHAPIRO
Milton, Del.

"Two grpigs to your one that Mariner Four gets here before Zond Two."

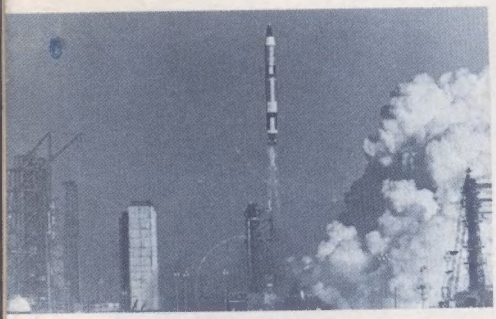
The moon face to face



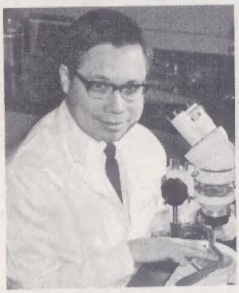
Long before the first U.S. expedition takes off for the moon, a thorough understanding of the guidance and control capabilities of the lunar spacecraft will be needed. At the National Aeronautics and Space Administration's Langley Research Center, Hampton, Va., scientists are developing a huge moon model as part of Lunar Orbit and Landing Approach (LOLA) simulator to give men and machines a realistic taste of the moon mission. LOLA will give pilots terrain simulations upwards of 150 feet above the moon's surface.

in this issue . . .

Understanding science is vital in governing America. How much does President Johnson know about science? How interested is he in it? See page 9.



Left: Very soon now, two American astronauts will be riding this rocket into orbit. For the latest developments in our space program, see page 14.

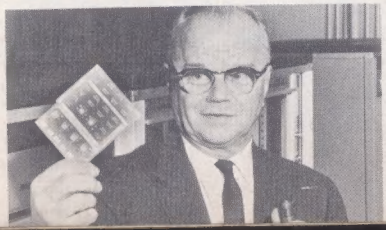


Under the microscope is an eel-like fish that breathes, walks and changes sex. More about this creature, page 12.

A group of Oklahoma prospectors sneaking around Alaska's Aleutian Range started a gold rush. But it wasn't gold the Oklahomans were after, it was iron. The story of how they found a billion tons of it by accident and how they outsmarted Alaskans to keep it, page 66.

What's new this month? One thing is a pneumatic gun that fires dry chemical fire-extinguishing powder directly into a fire. Details on this and other inventions and patents, page 26.

The XC-142A takes off vertically like a helicopter, lowers its tiltable wing and speeds forward like a conventional plane and then eases down to a vertical landing. See story on page 41.



Left: A bewildering variety of computers have flooded the market in the past few years. *Science Digest* presents a complete run down on today's computers beginning on page 75.